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REVISED

APRIL 1960

DEPARTMENT OF THE NAVY

BUREAU OF YARDS AND DOCKS

WASHINGTON 25, D. C.

ABC WARFARE DEFENSE ASHORE Revised TP-PL-2

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DEPARTMENT OF THE NAVY
BUREAU OF YARDS AND DOCKS
Washington 25, D. C.

April 5, 1960

This revised publication contains the latest information on the development of defense measures ashore against atomic, biological, and chemical warfare attacks. This information has been prepared in accordance with this Bureau's responsibility for the development, procurement, and distribution of materials and appliances for defense ashore against such attacks.

It should be emphasized that personnel who are responsible for planning for defense must be fully aware of the risks that are involved and of the ability of an activity to recover from an attack, whether it be atomic, biological, chemical, or any combination thereof.

The data given in this publication will be useful to all personnel who are concerned with planning for defense against ABC warfare attack and executing the recovery measures to be taken in the event of any attack. If adequate preparatory measures are taken, as outlined herein, substantial protection will be afforded against ABC warfare attack despite the increased effectiveness of such warfare and improvement in weapons.

E J Peltier
E. J. PELTIER

FOREWORD

This revised publication brings up to date and combines in one volume the data that were previously contained in Atomic Warfare Defense, NAVDOCKS TP-PL-2, Chemical Warfare Defense, NAVDOCKS TP-PL-3; and Biological Warfare Defense, NAVDOCKS TP-PL-4. It also contains a list of abbreviations, a glossary of terms, and a bibliography pertaining to ABC warfare and disaster control.

This publication delineates the authority and responsibility of the various bureaus and offices of the Navy Department in connection with planning ABC warfare defense, presents information on preparatory measures that are involved in planning and executing an ABC warfare defense program, and provides a description of techniques and equipment to be used by a disaster control organization.

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CHAPTER 1. GENERAL NATURE OF ABC DEFENSE

PART A. INTRODUCTION

Section 1. GENERAL

1A1.01 PURPOSE

This publication has been prepared by the Bureau of Yards and Docks to provide technical information for those who are concerned with (a) planning preparatory defense measures and minimizing the damage that might result from nuclear, biological, and chemical warfare attacks on the Shore Establishment; and (b) exercising control of areas that are contaminated as the result of accidents that involve nuclear weapons.

1A1.02 SCOPE

Various phases of ABC warfare defense and nuclear weapon accidents, as well as decontamination procedures and recovery measures, are covered. Specifically, this publication presents information on the following aspects of this subject.

(1) The most probable forms of attack by an enemy and the characteristics of weapons that are most likely to be used.

(2) The fundamentals of an ABC warfare defense and recovery program.

(3) A basis for organizing such a program.

(4) Detection, protection, and decontamination equipment, materials, and methods.

1A1.03 CANCELLATION

This revised publication cancels and supersedes Atomic Warfare Defense, NAVDOCKS TP-PL-2, revised 1 July 1956; Chemical Warfare Defense, NAVDOCKS TP-PL-3, revised 1 July 1955; and Biological Warfare Defense, NAVDOCKS TP-PL-4, revised 15 April 1953.

1A1.04 AUTHORITY AND RESPONSIBILITIES

By Article 0455 of United States Navy Regulations, 1948, the Bureau of Yards and Docks is responsible for the development, procurement, and distribution of materials and appliances for defense ashore against chemical, biological, and radiological warfare, except instruments that are used for the detection and measurement of radioactivity.

The Marine Corps, however, is responsible for supplying its own units, except when the units are under the management control of a bureau or office of the Navy Department.

1A1.05 DEFINITIONS

1. DISASTER CONTROL. Disaster control consists of measures that are taken to (a) reduce the probability of damage and (b) minimize the effects of damage caused by hostile action without employing active weapons or initiating offensive action. In addition, in relation to shore activities, disaster control is interpreted to include protection against damage that is caused by natural forces, as well as recovery from damage that is caused by such forces.

2. ABC WARFARE DEFENSE. ABC warfare defense consists of those disaster control measures that are employed to prepare for, and to minimize the effects of, atomic, biological, and chemical attacks.

1A2.01 DISASTER CONTROL PROGRAM

The principles that are common to atomic and biological warfare defense programs, along with similar principles in chemical warfare defense, have been jointly incorporated into an all-inclusive disaster control program for the Department of the Navy. This program involves the organization and training of personnel; the development and procurement of special equipment; the establishment of safety policies and regulations regarding atomic, biological, and chemical warfare hazards; research in damage control and decontamination procedures and in the medical treatment of large numbers of atomic, biological, and chemical warfare casualties; and the integration of defense measures into a program of defense against ABC warfare and other forms of attack or natural disasters.

1A2.02 BUREAU OF YARDS AND DOCKS FUNCTIONAL RESPONSIBILITIES

The specific interests and responsibilities of the Bureau of Yards and Docks in the area of ABC warfare defense as outlined by the Chief of Naval Operations are to:

(1) Develop techniques and devices for (a) the rapid detection and identification of chemical warfare agents and (b) the rapid detection of biological agents ashore.

(2) Develop equipment and material, except clothing and radiac instruments, for individual and group protection of personnel ashore.

(3) Furnish military characteristics for disaster control protective clothing and radiac equipment ashore.

(4) Develop methods, materials, and appliances for decontamination ashore.

(5) Incorporate protective features in new and existing structures to improve their resistance to ABC attack.

(6) Fund, initiate procurement action, and direct distribution of all disaster control material and equipment under the cognizance of the Bureau of Yards and Docks.

(7) Advise the Bureau of Supplies and Accounts of the requirements for disaster control standard stock material and equipment.

(8) Develop techniques for radiological monitoring ashore.

(9) Provide appropriate support and technical guidance on radiological monitoring and decontamination, ashore and in water areas, in the event of accidents involving nuclear weapons.

1A2.03 FIELD RESPONSIBILITIES

1. DISTRICT PUBLIC WORKS OFFICER. The Chief of the Bureau of Yards and Docks has delegated certain specific phases of his authority in the area of ABC warfare defense to the District Public Works Officers. Included are the technical planning aspects of ABC warfare defense programs of the Shore Establishment within the naval districts; this responsibility is assigned to the Disaster Control and Emergency Plans Branch (Code B-210).

2. PUBLIC WORKS OFFICER. The Public Works Officer has such authority as may be delegated and such responsibility as is assigned to him by his commanding officer for (a) the administration and operation of the technical aspects of the activity disaster control program and (b) the assignment and training of personnel in the Public Works Department to the disaster control organization.

1A2.04 RESPONSIBILITIES OF OTHER BUREAUS AND OFFICES

Other Navy bureaus and offices have been assigned by OpNav Instruction 04400.6A the responsibility to perform certain functions in basic allowance planning for ABC warfare defense ashore. These functions, which amplify the areas of responsibility that are stated in general terms in United States Navy Regulations, 1948, are outlined in the following paragraphs.

1. CHIEF OF NAVAL OPERATIONS.

(1) Establish policies with respect to organization, equipment, and personnel qualifications, assignment, and training.

(2) Coordinate bureau activities.

(3) Provide budgetary guidelines.

2. BUREAU OF AERONAUTICS (NOW BUREAU OF WEAPONS).

(1) Develop airborne detection instruments.

(2) Develop methods and equipment for individual and collective protection of personnel in aircraft.

(3) Develop equipment for radiological, biological, and chemical decontamination of aircraft.

(4) Develop materials for increasing the resistance of aircraft to thermal radiation.

(5) Investigate the ability of aircraft to withstand the effects of atomic weapons and recommend operational limits for all resulting hazards to aircraft and their crews.

(6) Procure and distribute all special disaster control material and equipment under the cognizance of the Bureau of Aeronautics (now Bureau of Weapons).

(7) Advise the Bureau of Supplies and Accounts of the requirements for disaster control standard stock material and equipment.

(8) Promote a high state of readiness, maintain liaison with other services and agencies, and keep the Navy informed as to the advances in technology as pertaining to nuclear accidents.

3. BUREAU OF MEDICINE AND SURGERY.

(1) Develop procedures and develop materials for the medical treatment of mass casualties that result from ABC attacks, and develop the various preventive medical measures appropriate to ABC defense.

(2) Advise agencies that are responsible for the provision of protection, decontamination, and detection devices as to the medical aspects involved in their operation or development.

(3) Develop techniques and devices for the rapid medical identification of biological warfare agents.

(4) Establish tolerances and regulations for radiation, and provide information on physiological effects of exceeding such tolerances by varying amounts.

(5) Investigate and develop means of increasing the resistance of individuals to the effects of atomic, biological, and chemical warfare agents.

(6) Train medical personnel, as required, to develop adequate ABC warfare defense.

(7) Procure and distribute all special disaster control material and equipment under the cognizance of the Bureau of Medicine and Surgery.

(8) Advise the Bureau of Supplies and Accounts of the requirements for disaster control standard stock material and equipment.

(9) Provide technical guidance on the medical aspects of nuclear accidents, and provide for required medical assistance to special teams.

4. BUREAU OF NAVAL PERSONNEL.

(1) Establish and promulgate qualification standards for personnel performing disaster control and damage control duties.

(2) Establish schools and conduct training and educational programs in the fields of disaster control and damage control.

5. BUREAU OF SHIPS.

(1) Investigate the effects of atomic explosives on ship structures and equipment, and make modifications where indicated and practicable.

(2) Furnish basic technical requirements for disaster control protective clothing afloat.

(3) Develop methods and equipment for decontamination of ships and their crews.

(4) Investigate radiological and thermal radiation phenomena and provide basic data to other interested agencies.

(5) Study the interrelation of various countermeasures for atomic weapons effects, and provide other agencies with data necessary for realistic planning.

(6) Develop techniques and devices for the rapid detection and identification of chemical warfare agents and the rapid detection of biological agents afloat.

(7) Develop all radiac equipment except airborne.

(8) Procure, distribute, maintain, and establish allowances for radiac equipment

for naval shore activities, aircraft squadrons permanently based ashore, and shore-based fleet activities.

(9) Develop, procure, and distribute all special disaster control material and equipment, except clothing, required for individual and group protection on shipboard.

(10) Advise the Bureau of Supplies and Accounts of the requirements for disaster control standard stock material and equipment.

(11) Provide the Chief of Naval Personnel technical assistance (a) in the development of training material, (b) advice on technical matters affecting the quality of training being provided, and (c) information on newly developed ABC warfare defense equipment on which training will be required.

(12) Provide technical guidance on radiological monitoring and decontamination afloat; provide necessary radiac equipment for use ashore and afloat suitable for use in the event of nuclear accidents.

6. BUREAU OF SUPPLIES AND ACCOUNTS.

(1) Develop methods and determine requirements for the protection of supplies in storage and in transit, and for their decontamination.

(2) Develop, procure, and distribute disaster control protective clothing.

(3) Procure and distribute stocks of approved disaster control emergency medical supplies as advised by the Bureau of Medicine and Surgery.

7. BUREAU OF ORDNANCE (NOW BUREAU OF WEAPONS).

Provide technical guidance for coping with accidents, ashore and afloat that involve unexploded nuclear ordnance, and for recovering fragments of such ordnance in a contaminating event.

8. JUDGE ADVOCATE GENERAL.

Provide to appropriate commands preplanned legal measures to be utilized in event of an accident with nuclear weapons.

9. CHIEF OF INFORMATION.

Provide preplanned public information measures for use in accidents involving nuclear weapons.

1A2.05 RESPONSIBILITIES OF COMMANDANTS OF NAVAL DISTRICTS AND RIVER COMMANDS

In accordance with the provisions of General Order 19, the commandants of naval districts and river commands are responsible for the defense of their naval districts and river commands and control of local disasters or emergencies, including disasters or emergencies resulting from ABC warfare attack.

PART B. CONCEPTS OF ATTACK AND DEFENSE IN ABC WARFARE

Section 1. ABC ATTACK

1B1.01 PURPOSES

Nuclear weapons (AW) and radiological (RW), biological (BW), and chemical (CW) agents have various potentials when used in an attack. Nuclear weapons are designed to (a) produce casualties among personnel as a result of blast effects, thermal or heat effects, and nuclear radiation and (b) destroy buildings and equipment by heat and blast. Similarly, certain biological and chemical agents may be employed to (a) inflict casualties upon personnel and animals or (b) cause destruction of agricultural crops. Casualties to personnel may range from slight incapacitation or minor injuries to death. The employment of RW, BW, and CW agents might be made a part of a general attack plan, or separate attacks might be staged by using single agents or any combination of agents and weapons. The RW, BW, and CW agents can not be used to destroy structures and equipment, but instead they would probably be employed to (a) produce a contamination that would render structures and equipment temporarily unusable, (b) assure that the use of structures and equipment could be undertaken only if severe personnel casualties were accepted as a calculated risk, and (c) require considerable decontamination effort. The residual radioactivity that results from a nuclear explosion may also prevent the use of land areas, installations, and equipment for a considerable period of time.

Essential wartime production is not limited to the construction of ships, airplanes, vehicles, guns, and ammunition but also includes the production of food and other essentials that are necessary for the civilian population and the men under arms. Crops and domesticated animals are therefore potential targets for RW, BW, and CW agents.

1B1.02 METHODS

A variety of weapons and delivery methods may be employed in an ABC attack. It is possible that two or more types of weapons might be employed simultaneously if the mission were sufficiently important.

1. MANNED AIRCRAFT. In addition to delivering nuclear weapons, airplanes may also be utilized to deliver various agents, either in bombs or in the form of gases or minute particles that are dispersed in air to form aerosols. Low-level aerial spray may be a favored method of delivering certain BW and CW agents in future warfare. This method of delivery could also be adapted to RW agents.

2. PROJECTILES. Atomic warheads have been designed for use in such weapons as the 8-inch howitzer and the naval rifle. In the past, chemical agents have been incorporated in projectiles and used effectively, and similar possibility exists with selected BW agents. The types of weapons selected would depend on the objective; for example, structural damage, casualties, or the denial of an area through contamination.

3. GUIDED MISSILES AND ROCKETS. Missiles obviously provide another means of conveying AW weapons or an assortment of RW, BW, and CW agents to a target area. Missiles provide a means of delivery at medium and long ranges without the use of manned aircraft. Moreover, the incorporation of BW and CW agents in the warhead is a possibility.

4. MISCELLANEOUS DELIVERY METHODS. Consideration must be given to the possibility of using balloons to convey incendiaries, other CW agents, or RW and BW agents. In addition, BW agents may be delivered by such unusual methods as parachutes, gliding or whirling bomblets of small size, flying animals such as birds and bats, or by the insect vectors for certain agents.

5. COVERT ATTACK. Sabotage provides another potential method for the use of ABC weapons and agents. The components of nuclear weapons could be smuggled into an area and later assembled at an appropriate time and place. Nuclear weapons and weapons that incorporate CW components, however, are limited in potential by their design and mass. Various types of biological agents are not so restricted. A relatively small amount of BW agent culture, produced with ease by a semiskilled technician, may be used subsequently to infect many individuals. It is even possible that an epidemic might ensue, although good public health measures would reduce the probability.

In general, the methods that might be employed in a covert attack are limited only by the degree of the security measures in force and the imagination of the saboteur. BW agents present the most attractive possibilities for effective use, but AW weapons and certain CW agents can not be ruled out as possibilities.

1B1.03 LIKELIHOOD OF ATTACK

An enemy may possess a given ABC weapon, but elect not to employ it because of sure knowledge that retaliation in kind would be made with devastating effect. The possibility of abstention by an enemy, however, must never be depended upon to assure the safety of American forces, because such an attitude clearly represents false security. The potential of CW agents was proved during World War I. Nevertheless, except for chemical warfare in the form of incendiaries, smoke, and flame, CW agents were not employed in World War II, and BW agents have not been proved in combat. Both BW and CW munitions are more restricted by weather conditions than are other types. It can not be assumed, however, that a potential enemy will necessarily give consideration to such facts. The use of kamikaze methods in World War II is a well-known example of deviation from accepted methods of attack. It is for these reasons that an effective ABC defense program must be developed and maintained. Therefore, in formulating a program, an evaluation must be made on the likelihood of attack on a particular area. In this publication, target areas are defined as concentrations of population and/or industry; prime targets are concentrations of population and/or industry and installations of the armed services or Federal agencies that are considered to be essential to the prosecution of a war. The identity of prime targets is classified information that may be obtained only from appropriate classified instructions. The Office of Civil and Defense Mobilization publishes annually a manual, Target Areas for Civil Defense Purposes, that may be helpful in planning for disaster control. Once it has been determined that an area is a potential target, the possible effects on defense must be estimated. A discussion on this subject, insofar as a nuclear attack is concerned, is contained in Protective Construction and Personnel Shelters, NAVDOCKS TP-PL-8, Revised.

Section 2. ABC DEFENSE

1B2.01 PURPOSES

Because it is necessary to maintain the Shore Establishment in a state of readiness to fulfill its mission at all times, plans, organization, equipment, and training to effect recovery are of vital importance. So are pre-attack measures, such as duplication, dispersal, camouflage, strengthening of structures, and provision of shelters.

Recovery measures are steps that are taken after an attack to restore the functional status of an activity. Such measures have been divided into three phases and are defined as follows:

(1) Emergency recovery measures: immediate actions taken to keep loss of life and property at a minimum.

(2) Operational recovery measures: actions taken to restore the essential mission of an activity.

(3) Final recovery measures: actions taken to restore all normal functions of an activity.

1B2.02 METHODS

Because wide areas will be affected during an ABC warfare attack, defense planning must provide for collective assistance among all naval activities within an area. In addition, Navy planning must be coordinated with the planning of other military services and the planning of Federal, State, and local civil agencies.

As set forth in General Order No. 19, all naval shore activities within a naval district are under the military command or coordination control of the commandant on matters that are related to disaster control and security. A naval activity that is outside the geographical limits of a naval district is under the military command or control of the appropriate fleet or naval force commander.

1B2.03 SUMMARY

In summary, ABC warfare defense includes:

(1) Planning an organization that is effective and capable of dealing with extensive and widespread damage.

(2) Assignment and training of personnel.

(3) Special construction or alteration of existing structures to provide security for personnel and equipment.

(4) Procurement and safe storage of equipment that is needed for supply and recovery.

(5) Employment of personnel and material to effect rapid recovery after an attack or natural disaster, so that the normal functioning of the naval activity may be reestablished without unnecessary delay.

CHAPTER 2. CHARACTERISTICS OF ABC ATTACK

PART A. NATURE OF ABC ATTACK

Section 1. GENERAL APPLICATION OF WEAPONS

2A1.01 MULTIPLE APPLICATION

ABC weapons and agents may be used for strategic effects, as well as for tactical purposes. In addition to the blast and thermal effects of nuclear weapons, the various AW, RW, BW, and CW weapons and agents produce a variety of unique results that may be summarized under the general designation of contamination.

Contamination results when radioactive substances, BW agents, or CW agents, or any combination thereof, are present in a quantity that is large enough to constitute a hazard to personnel.

2A1.02 MOBILITY AND PERSISTENCY

All ABC agents have characteristics of mobility. For example, when a nuclear explosion takes place, a fallout of radioactive materials occurs downwind, and it may cover a considerable area. When RW agents and war gases are released by any one of the existing methods, they become dispersed and the area of dispersion may be extensive.

The persistency factor is important also for most ABC weapons. As described in paragraph 2B1.09, radioactive substances undergo decay, which is relatively rapid for some substances and prolonged for others. Potential BW agents include types that might be expected to have temporary and limited effects and other types that would continue to function over a considerable period of time. The CW agents also vary with respect to their persistency.

2A1.03 MISSION

For a given mission, a nonpersistent agent might be desirable for an attack in an area soon to be occupied by the attacking forces. Conversely, a highly persistent agent would be the obvious choice if it were intended to deny a given area to the defending forces for an indefinite period of time with no concern regarding occupancy by the attacking forces. Similarly, a weapon that produces major blast and heat effects would probably be selected to destroy installations and materials; but if the mission called for capture rather than destruction of the installation, a weapon that did not produce excessive blast and heat effects would be preferable.

Section 2. TYPES OF WEAPONS AND AGENTS USED

2A2.01 NUCLEAR WEAPONS

On 6 August 1945 the first military use of an atomic bomb as an airburst wreaked havoc upon Hiroshima, Japan. On 9 August 1945 a similar blast did enormous damage to Nagasaki. Termination of Japanese resistance undoubtedly was in part dictated by the realization that an entirely new type of weapon having enormous destructive capacity had become a factor in modern warfare. A typical atomic surface burst is shown in Figure 2-1.

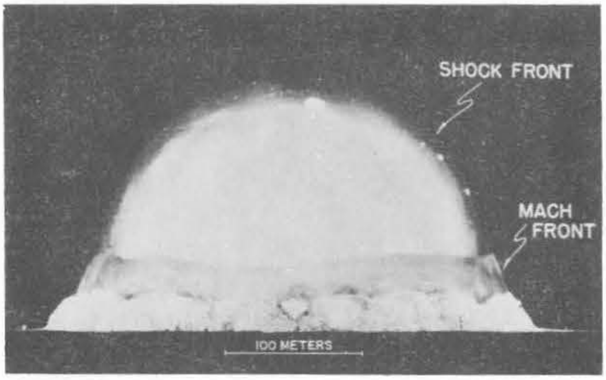


Figure 2-1. Atomic Surface Burst

Since 1945 even more destructive weapons have been developed in the form of thermonuclear bombs, which use fusion as well as fission for their energy.

2A2.02 RW AGENTS

In the fission process, various radioactive isotopes of a number of elements are produced. These radioactive substances have varying degrees of persistency. Similar radioactive substances are developed in the operation of atomic piles, and there is some chance that they may be used as independent weapons to contaminate areas, structures, equipment, and personnel. This process is known as radiological warfare, or RW, and the radioactive substances that are employed are the RW agents.

2A2.03 BW AGENTS

1. In a sense, defense against BW agents has always been carried on. Disease germs have been a part of human experience throughout the centuries, although many of them were not identified until comparatively recent times, and some of them undoubtedly remain unknown today. The term "biological warfare" as used herein means the deliberate and directed use of BW agents to gain a military advantage.

2. Epidemics of disease have long been a problem in times of war, affecting both military and civilian populations and often accounting for more casualties than the accepted weapons of the times. Before the days of typhoid inoculation, typhoid fever was an inevitable and very real hazard of military life. Armies were similarly decimated by typhus fever, malaria, and yellow fever until effective control measures were devised.

3. A question naturally arises on whether directed attacks that employ BW agents would be significantly more devastating than the epidemics that have long been a part of human experience. Only actual tests can provide an answer, and as yet such tests have not been made. It is known, however, that our defenses against pathogens are better today than they have ever been.

2A2.04 CW AGENTS

1. There is nothing new about the concept or the basic process of chemical warfare. Pitch pots, reportedly used to defend Troy in about 1200 B.C., or Greek fire, used in the seventh century B.C., may have been the first use, because the use of incendiary materials is usually classified as a type of chemical attack. In the past half century the agents and methods of CW have been modernized, and the various technical advances must be considered in planning an adequate defense. The CW agent of today may be a liquid, gas, or solid substance that produces lethal, injurious, or irritant effects. However, it can have an incendiary action or it can be a screening or signaling smoke.

2. The use of modern war gases began in World War I when the Germans released chlorine gas from cylinders at Ypres in 1915. Supported by the element of surprise, this lung irritant proved to be extremely effective in the initial attack, and in the months that followed the Germans successively employed a number of other lung irritants, including phosgene. In 1917, the Germans introduced mustard gas. The nitrogen mustard agents were available to both the Germans and the Allies in World War II. The Germans also produced during World War II a group of phosphorus compounds known as the G-agents, or nerve gases. These G-agents can enter the human body via both lungs and skin, and in sufficient dosage they will

inactivate substances that are vital to the function of the nervous system. Potentially, the G-agents, because of their high toxicity and the rapidity of their action, are much more deadly than older CW agents.

3. Incendiary bombs were used to some extent during World War I. Some of them contained thermite and some white phosphorus. Similar weapons, including large napalm bombs and projectiles with white phosphorus components, were used extensively during World War II. Napalm, which is not particularly flammable, is a white powder that is used to thicken gasoline, but the term "napalm bomb" implies that napalm has been used in the bomb. Thickened gasoline contains 3 to 8 percent of napalm; bombs, 5 or 6 percent; portable flame throwers, 3 or 4 percent; and mechanized flame throwers, about 8 percent.

PART B. CHARACTERISTICS AND EFFECTS OF ABC WEAPONS

Section 1. NUCLEAR WEAPONS

2B1.01 TYPES OF BURSTS

A nuclear weapon can be detonated as (a) an airburst in which the fireball does not extend down to the surface, (b) a surface burst in which the fireball does extend down to the surface, or (c) a subsurface burst where the center of the explosion is beneath the surface. In any type of burst the surface may be either land or water. The discussion in this publication has been limited to specific effects of nuclear weapons and does not cover basic phenomena. For additional information, see Effects of Nuclear Weapons, prepared by the Department of Defense and published by the Atomic Energy Commission.

2B1.02 BLAST EFFECTS

All bursts produce blast effects that differ according to the type of burst and the medium through which the blast or shock wave is traveling. Blast pressures are measured in pounds per square inch (psi).

1. AIRBURST. In an airburst, virtually at the moment of the explosion, a characteristic ball of fire begins to take form, and about 17/1000th second after the explosion, the direct shock wave begins to move outward from the ball of fire. The shock wave covers the first 500 yards in about one-half second and reaches a distance of 2,000 yards from the explosion center in about four seconds. The velocity equals the speed of sound for the atmosphere and temperature conditions that exist in the shock front. After a shock front has traveled outward a certain distance, the pressure behind it falls to less than one atmosphere. This creates a partial vacuum into which air tends to rush, thus producing the phenomenon that is described as the negative phase of the shock wave. Ordinarily, the positive or pressure phase of a shock wave can be expected to do most of the damage, but the effect of the negative phase is considerable and must also be anticipated.

2. SURFACE BURST. The area of damage from a weapon that is detonated as a surface burst is likely to be of less magnitude than the area of damage from a similar weapon that is detonated as an airburst. This is true because more of the energy of a surface burst goes into ground shock and into vaporizing materials at the earth's surface. Thus, there is a tendency toward (a) overdestruction of installations at ground zero and (b) corresponding underdestruction with an increase of range from ground zero.

3. UNDERGROUND BURST. An underground explosion causes a shock wave in earth and rock and, although the shock wave travels faster than an accompanying shock wave in air, it loses its potency more rapidly. The pressures that are developed in an underground burst depend to a considerable extent on the depth of the burst, because if the location of the burst is relatively shallow, the gases of the fireball will break through the surface quickly to bring relief from pressure.

4. UNDERWATER BURST. a. In an underwater burst, the characteristic fireball of hot, compressed gases is formed and rises to the surface. Meanwhile, a shock wave in the water proceeds outward from the point of the explosion. This underwater shock wave moves faster than a shock wave in air. It has very high initial overpressures near the center of the explosion. Overpressures, however, fall off quite rapidly as range increases.

b. When the fireball breaks through the surface, a blast wave is produced in air and a hollow column of water is thrown upward. Gases from the fireball are vented up through the middle of the column. Very roughly the blast wave in air for a shallow underwater burst is about half of what a comparable bomb would produce if the burst took place in air. Thus, the comparative destructive range of the weapon to surface structures is considerably reduced.

c. A series of water waves that move out from the target center is also produced. Figure E-1 (Appendix E) provides information concerning wave height for a 1-kt burst and a formula for computing wave heights that are produced by bursts of different magnitudes and at various depths.

5. COMPARISON OF BLAST EFFECTS. It is possible to compare the blast effects that may be anticipated when bombs of various energies are detonated. In the estimating of overpressures that are produced under similar conditions for various sizes of weapons, a scaling rule can be applied, even though special characteristics of terrain may sometimes impair the accuracy of the estimates. Thus, in an airburst, the range from ground zero at which a specified overpressure is attained is proportional to the cube root of the bomb's energy yield.

Figure E-2 (Appendix E) shows ranges from ground zero at which certain peak overpressures are attained in the airburst of a 1-kt bomb, and it provides the scaling formula for computation of results with bombs of other magnitudes. Figure E-3 supplies the same kinds of information for surface bursts. Figure E-4 does likewise for shallow water bursts. Figure E-5 provides a cube root scaling curve for use in making the computations and explains how the cube root scaling curve is used.

2B1.03 THERMAL EFFECTS

In air, thermal radiation is given off in two pulses. For a kiloton weapon, the first pulse lasts for about 1/100th part of a second, and for a megaton weapon, the first pulse duration is about 1/10 second. Extremely high temperatures that consist largely of ultraviolet radiation are produced. In either instance, the first pulse involves only about 1 percent of the total thermal radiation and is not likely to do extensive damage except at short range.

The second pulse follows immediately upon the first. It lasts several seconds and carries about 99 percent of the total thermal radiation energy. Although the temperatures are not as high as in the first, this radiation causes most of the heat damage. These rays travel in straight lines and are stopped by even thin, opaque substances. In an airburst of a 20-kt weapon, the second pulse will cause skin burns at a range of two miles from ground zero. Because the duration of the pulse is several seconds, very prompt evasive action can <u>reduce</u> the damage to personnel.

It is difficult to make accurate estimates of thermal energy that is received at a given range from ground zero, as the result of the detonation of bombs that have different magnitudes, because of such variables as the height of the burst above surface and the state of the atmosphere at the time. Smoke and water in the air decrease the effective range of thermal radiation materially and, therefore, the result at one time may be different from the result at another time.

If a clear day and a given height of burst is assumed, it is possible to make reasonably accurate predictions. The scaling rule is that the amount of thermal energy received at a given range from ground zero will be directly proportional to total bomb energy release.

Thermal energy is measured in calories per square centimeter (cal/sq cm). If an airburst of a 100-kt bomb delivers 10 cal/sq cm at a slant range of 13,000 feet, a similar burst of a 1,000-kt bomb will deliver 100 cal/sq cm at the same slant range (Figure 2-2). Reference should be made to Figure E-6, which shows variation of thermal energy with slant range for a 1-kt airburst. Although the total thermal energy may be estimated from these curves, the yield of weapon must be considered in the estimation of the potential damage from any level.

2B1.04 INITIAL NUCLEAR RADIATION

An atomic burst is accompanied by the emission of gamma rays, which travel at the speed of light and have considerable penetrating power. In addition, some free neutrons and alpha and beta radiations are also liberated. The gamma and neutrons make up the major portion of this radiation, and the alpha and beta emissions are usually ignored, except in the immediate area of the explosion, because they have a much shorter range. Taken together, these factors constitute what is known as initial radiation. All of the initial radiation is received within one minute after an explosion, about 50 percent arriving within the first second, as shown in Figure 2-3. Initial nuclear radiation from a surface burst is similar to that of an airburst. The slant range to any object outside of target center is also shorter in the surface burst; but, conversely, gamma rays are subject to shielding by earth, rocks, and the walls of buildings.

1. GAMMA RADIATION DOSE. Initial gamma radiation dose is measured in units that are called roentgens (r). Figure 2-4 shows initial gamma radiation dose at different slant ranges from a 1-kt airburst, but may also serve to give approximations for surface bursts. For yields other than a 1-kt burst, the initial gamma radiation dose varies as shown in

$$Y = Y_o \text{ x scaling factor}$$

where

Y = the dose received from a W-kt burst at the given range

Y = the dose received from a 1-kt burst at the given range

Scaling factor is obtained from Appendix E, Figure E-7.

Consider the computation of the initial gamma radiation dose at one mile for a 100-kt burst. Figure 2-4 shows that for a 1-kt burst at one mile the initial gamma radiation dose (Y_o) is 2.3 r. Figure E-7 gives the scaling factor for a 100-kt burst as 150. The scaling equation then becomes

$$Y = 2.3 \times 150$$

$$Y = 345.$$

At the range of one mile, then, the initial gamma radiation dose that is received for a 100-kt burst is 345 r.

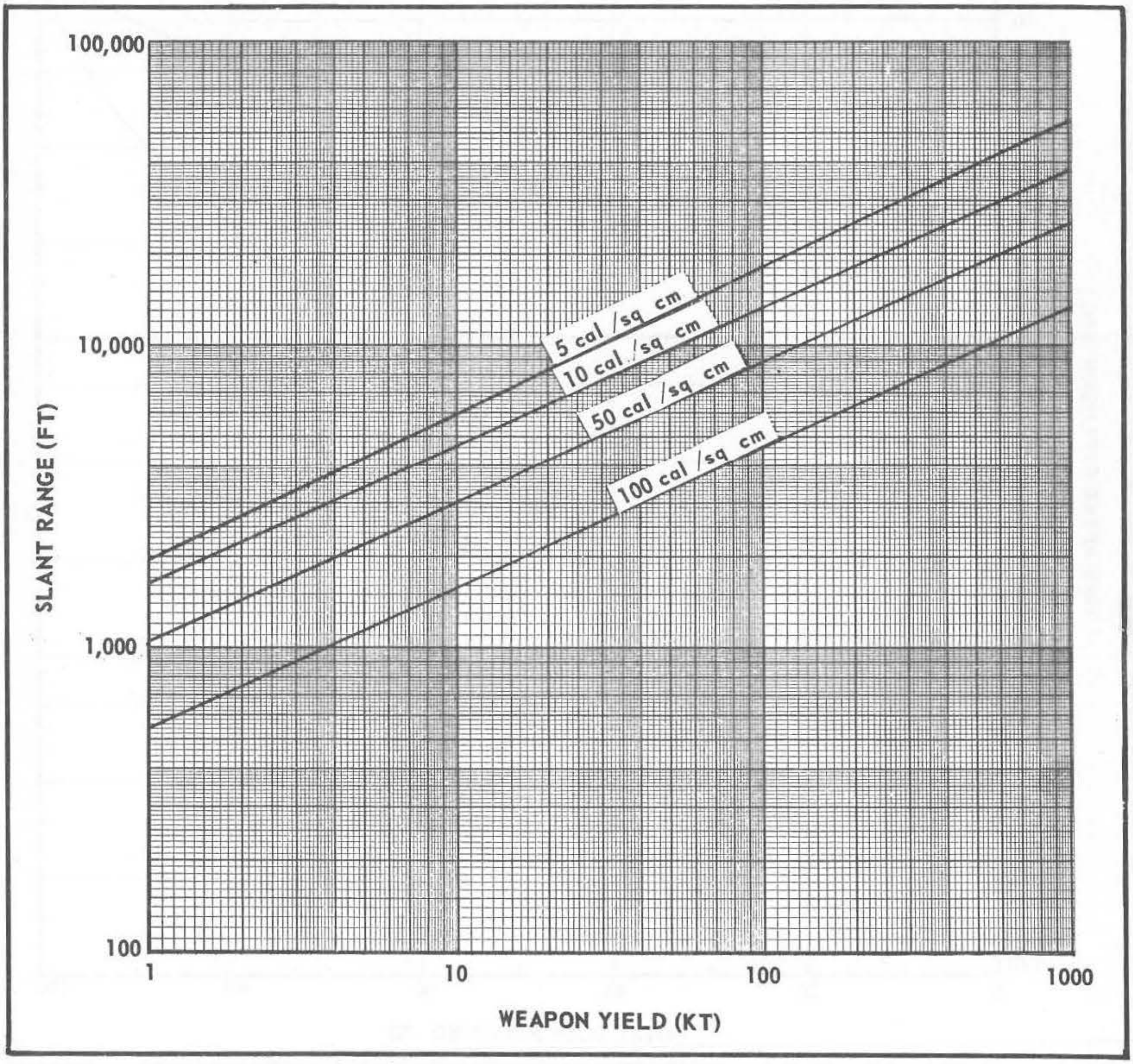


Figure 2-2. Thermal Energy Received From an Airburst at Various Distances as a Function of Weapon Yield--Visibility 2 to 50 miles

2. NEUTRON RADIATION DOSE. The unit "rem" is used to designate neutron radiation biological dose. Figure 2-5 shows the neutron radiation dose in rem at various slant ranges for a 1-kt burst. For bursts of greater magnitude at the same slant range, the dose varies according to

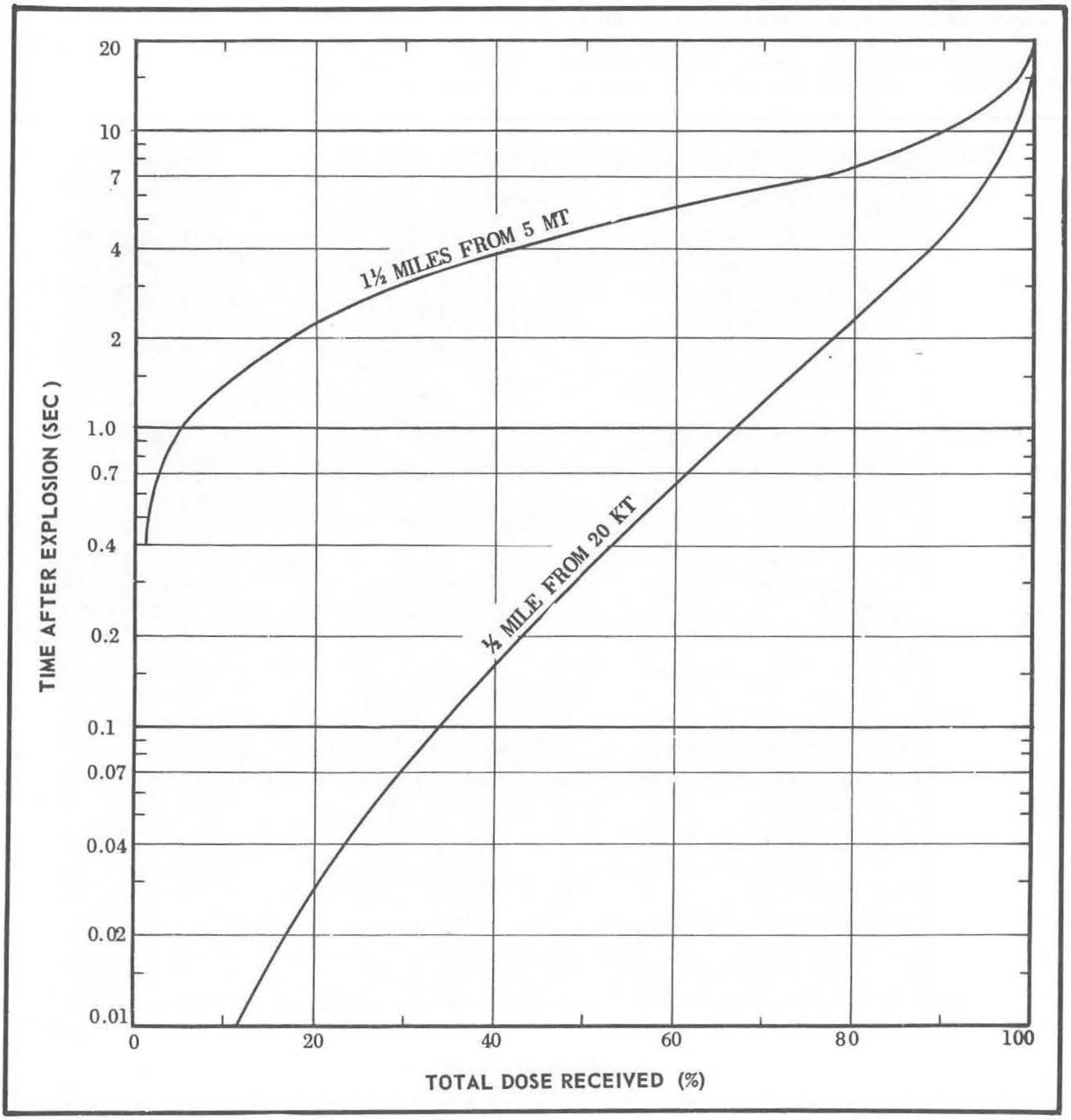


Figure 2-3. Percentages of Total Dosage of Initial Gamma Radiation Received at Various Times After Explosion

$$\text{rem} = (\text{rem})_1 \times W$$

where

rem = dose received from a 1-kt burst
(rem) = dose received from a W-kt burst
W = yield of the weapon in kt.

Figure E-8 shows initial gamma radiation doses as they relate to various peak overpressures, and indicates how the curves may be used. Figure E-9 shows neutron radiation dose rem in relationship to various peak overpressures, and explains how the curves may be used.

2B1.05 FALLOUT

When a nuclear explosion occurs, fission products, unfissioned materials, and neutron-induced radioactive particles sooner or later return to the surface as a fallout. The behavior of any particular fallout varies, depending on the type and magnitude of the burst, the terrain, the prevailing atmospheric conditions, and other factors. For this discussion, fallout may be arbitrarily divided into early fallout and remote fallout.

1. EARLY AND REMOTE FALLOUTS. Early (close-in) fallout occurs at and in the vicinity of the target area. It consists of the larger solid particles that are sucked up or blown up into the pillar and cloud that are developed in an atomic or thermonuclear explosion; the particles return to the surface contaminated with fission products. Remote fallout occurs days, months, and even years later. It is composed of small particles of fission products and other materials that have been carried high into the atmosphere and for considerable distances by the winds before they settle back to the surface of the earth. Many of the radioactive particles in remote fallout will have undergone significant degrees of radioactive decay because of timelag.

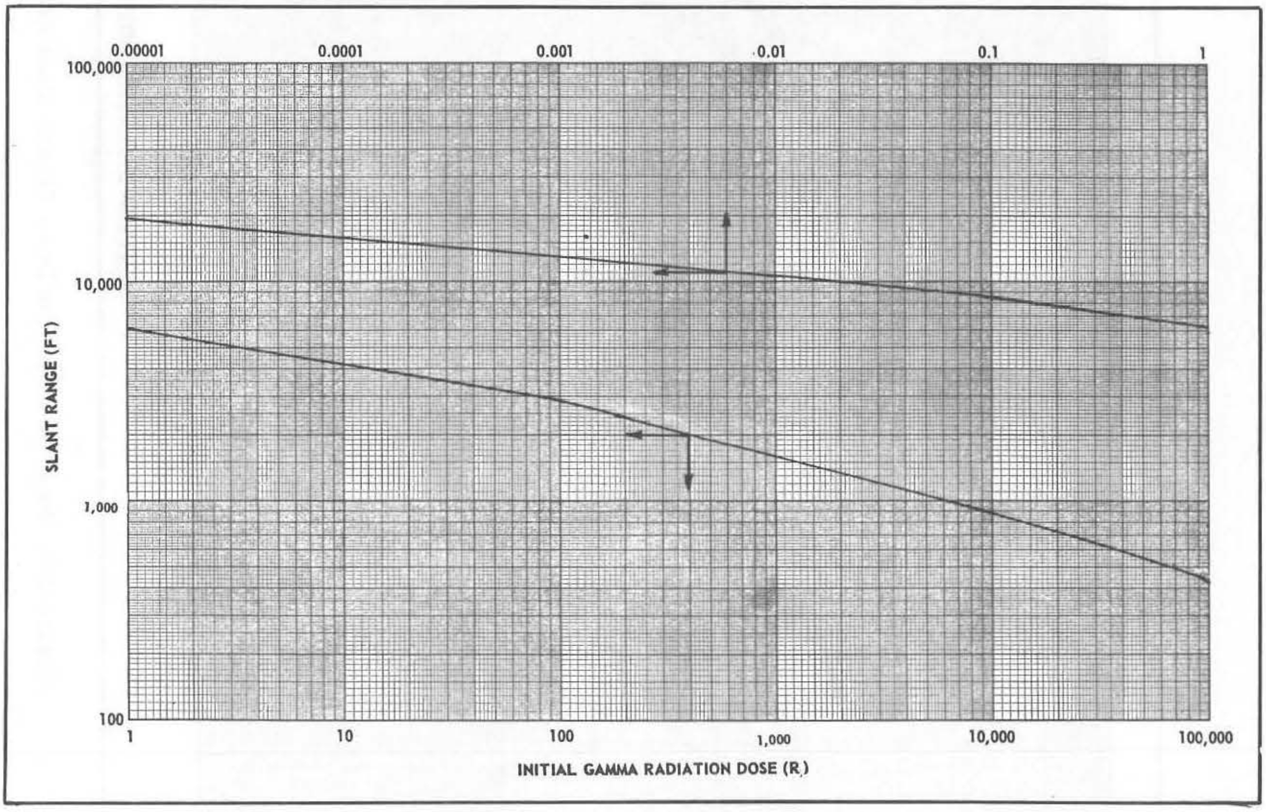


FIGURE 2-4 Initial Gamma Radiation Dose Versus Slant Range for a 1-kt Airburst

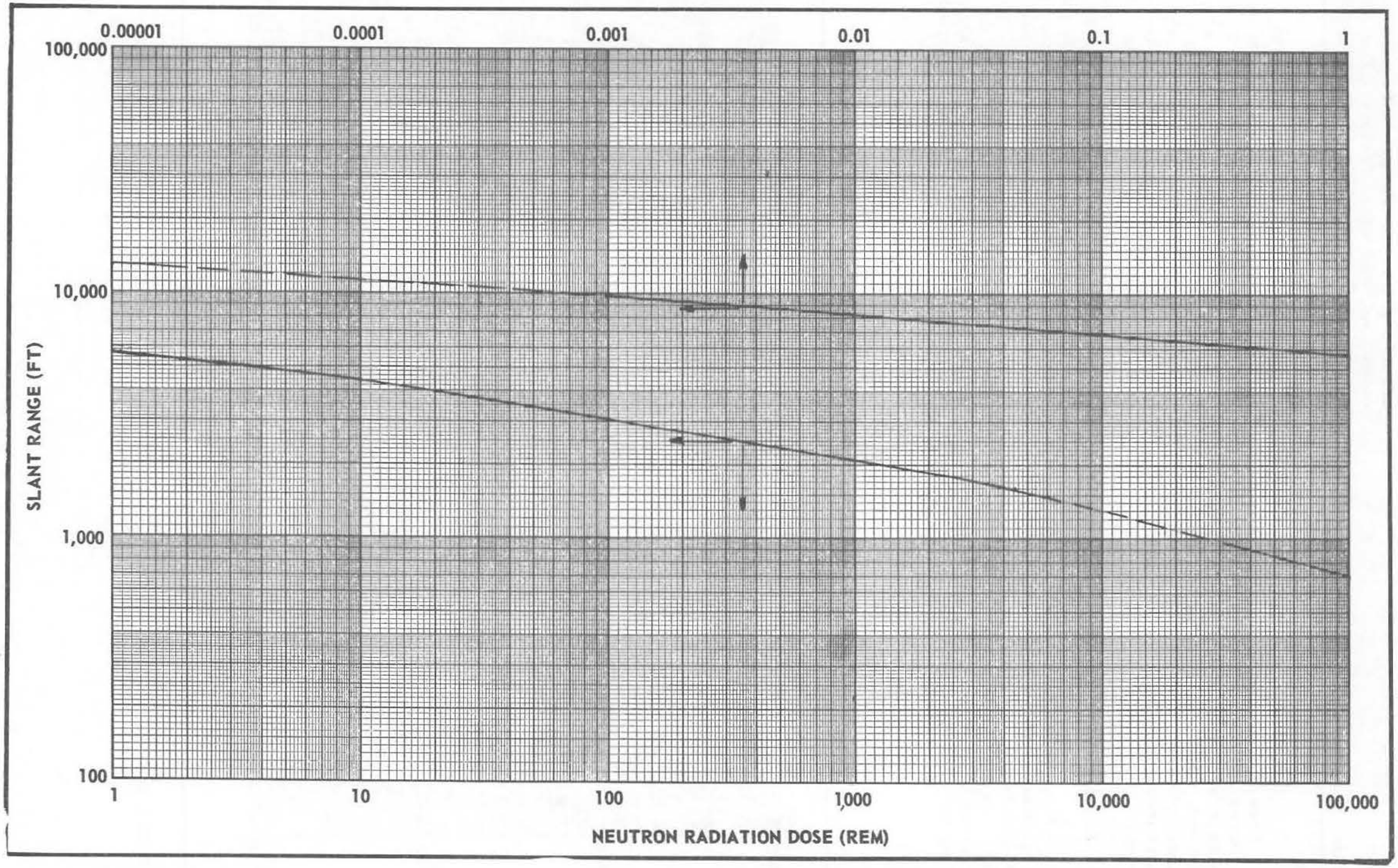


Figure 2-5. Neutron Radiation Dose Versus Slant Range For a 1-kt Airburst

2. FALLOUT IN RELATION TO BOMB YIELD. When a nuclear bomb is detonated as an airburst, the fallout is not likely to be an important hazard, because there would be little if any close-in fallout and the remote fallout may be disregarded from the military standpoint. When surface and subsurface bursts occur, however, the early fallout will be an important hazard.

The fallout from a hydrogen bomb in the multimegaton range is quite different. The fireball is much larger, being more than four miles in diameter when a 20-megaton bomb is detonated. A burst of such a bomb at a 10,000-feet altitude would constitute a surface burst in which material from the ground would be drawn up into the column and resulting cloud. When tested in the Pacific Proving Grounds, a bomb of this approximate energy produced a downwind early fallout that was about 140 miles long and 20 miles wide. Any unprotected personnel in this area probably would not have survived. The area of lesser contamination, in which there would have been some survival of unprotected personnel (but also some injuries, including subsequent fatalities), extended downwind to 220 miles and laterally for 60 miles (Figure 2-6).

In the interpretation of Figure 2-6, it should be noted that radioactivity of the fallout might be lethal to all unprotected personnel in Area I, and lethal to 5 to 50 percent of unprotected personnel in Area II. Area III also would be one of potential radioactive hazard. If a wind as indicated is assumed, the cigar-shaped pattern of local fallout appears to be characteristic of multimegaton surface bursts.

Residual radiation dose rate contours from a 1-mt surface burst fallout pattern are shown in Figure E-13 and Table E-1. The contours of such patterns depend to a considerable extent upon wind velocity. Paragraph E13 and Table E-1 also provide (a) scaling formula for weapon sizes other than 1 mt, and (b) adjustment factors for various scaling winds.

2B1.06 INDUCED RADIATION

Near ground zero, induced radiation may be a factor in determining the amount of radioactive contamination. Induced radiation develops when the free neutrons of an atomic burst penetrate certain (but not all) substances. As the height of burst increases, the amount of induced radiation decreases for any given weapon. For airbursts (more than one fireball height), this is not likely to be a factor of consequence. In underwater bursts, the salt in the seawater can be a source of considerable induced radioactivity, but probably will be contained and dissipated by settling and wave action. However, in surface or underground bursts, there is great possibility that various substances will be rendered radioactive.

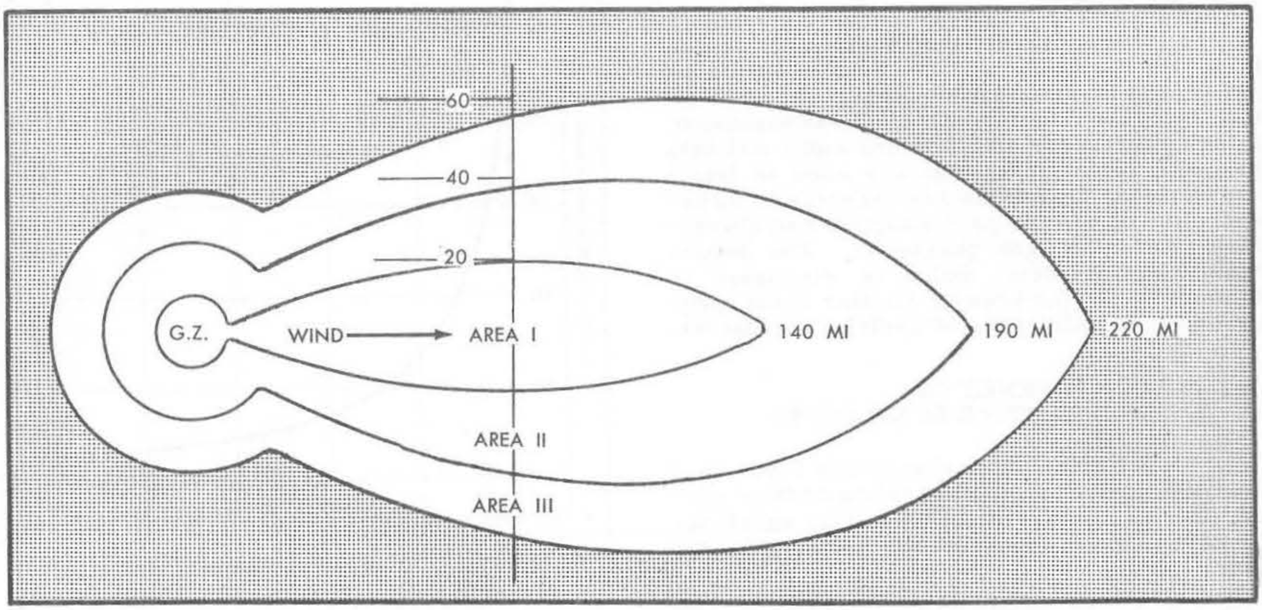


Figure 2-6. Pattern of Early Fallout Produced by Multimegaton Surface Burst

2B1.07 UNFISSIONED PLUTONIUM AND URANIUM

Another potential factor in contamination is the presence of unfissioned plutonium and uranium. These substances emit alpha particles and under certain conditions may also give off some gamma rays. Alpha particles, however, cannot travel more than three inches in air and will be stopped by clothing or even unbroken skin. It is believed that they are only a minor hazard, unless unfissioned particles of plutonium are ingested or inhaled.

Plutonium particles are only likely to be a military hazard after an accident such as a fire that involves nuclear weapons. (See Appendix B.)

2B1.08 RW CONTAMINATION

It is possible to spread radioactive elements (usually only one) over a target. These elements are known as RW agents, and they have a predetermined rate of decay, as might be dictated by strategic or tactical requirements. In one situation it might be desired to deny access to an area for only a brief interval of time, and in another, to deny access indefinitely. The radioactive substances could be dispersed within a selected area. Here the effect of these substances would be similar to that of any radioactive contamination, and the substances would be selected to produce casualties among personnel or to deny access to areas.

From the defense standpoint, therefore, the problem of RW contamination is usually the same as the problem of the residual radiation that results from a nuclear explosion. Even though there may be more alpha and beta hazards, instruments that are used to detect and measure dose rates are the same in either case, and so are the psychological and physiological effects upon personnel. The decontamination problem, which is discussed in Chapter 4, is also broadly similar to that produced by certain types of nuclear explosions.

2B1.09 PERSISTENCY OF RADIOACTIVE SUBSTANCES

A radioactive substance is made up of atoms that undergo disintegration as time goes on. All of the atoms in a radioactive substance do not undergo change at the same time, but there are so many atoms in even a relatively small amount of matter that the average rate of decay is predictable. The half-life of such a substance is the length of time in which half of its atoms will break down.

It may be shown that the process of radioactive decay has great significance in its relationship to radioactive contamination. The half-lives of various elements vary greatly, for example, that of lutecium 176 is 75 billion years and that of polonium 212 is only three ten-millionths of a second. After a nuclear explosion, a great many different radioactive substances are included in the residual radioactivity, and among these substances are some that have relatively short half-lives and others that have longer half-lives. This might, at first, seem to constitute a hopelessly complicated situation. For practical purposes, however, the important factor is the average rate of decay, which is predictable.

2B1.10 RADIOACTIVITY DECAY RATES

The decay rate that applies to the mixture of fission products that result from an atomic explosion is represented in Figure 2-7. In this graph the dose rate is arbitrarily set as a value of 100 at one hour after the explosion. During the following two hours the percentage of residual radioactivity diminishes rapidly, and at four hours it is down to about one fifth of its initial magnitude. Further data of value in computing decay rates (dose rate versus time after explosion) will be found in Figure E-14 and paragraph E14.

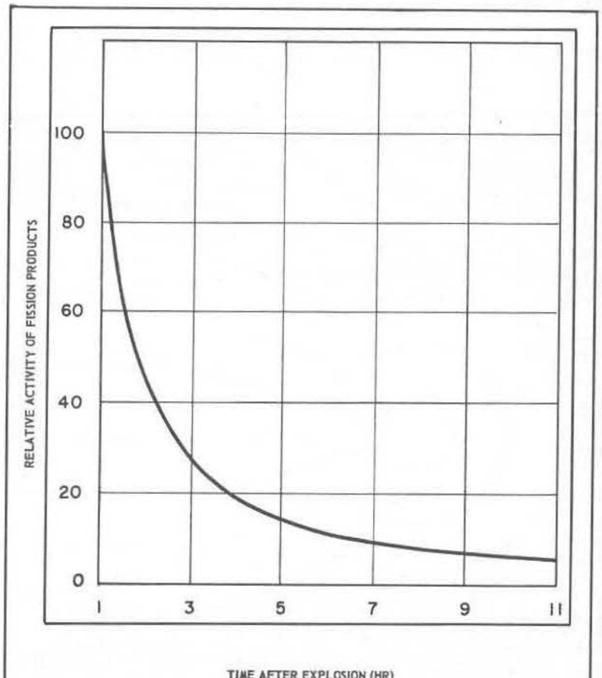


Figure 2-7. Rate of Decay of Mixed Fission Products After an Atomic Explosion

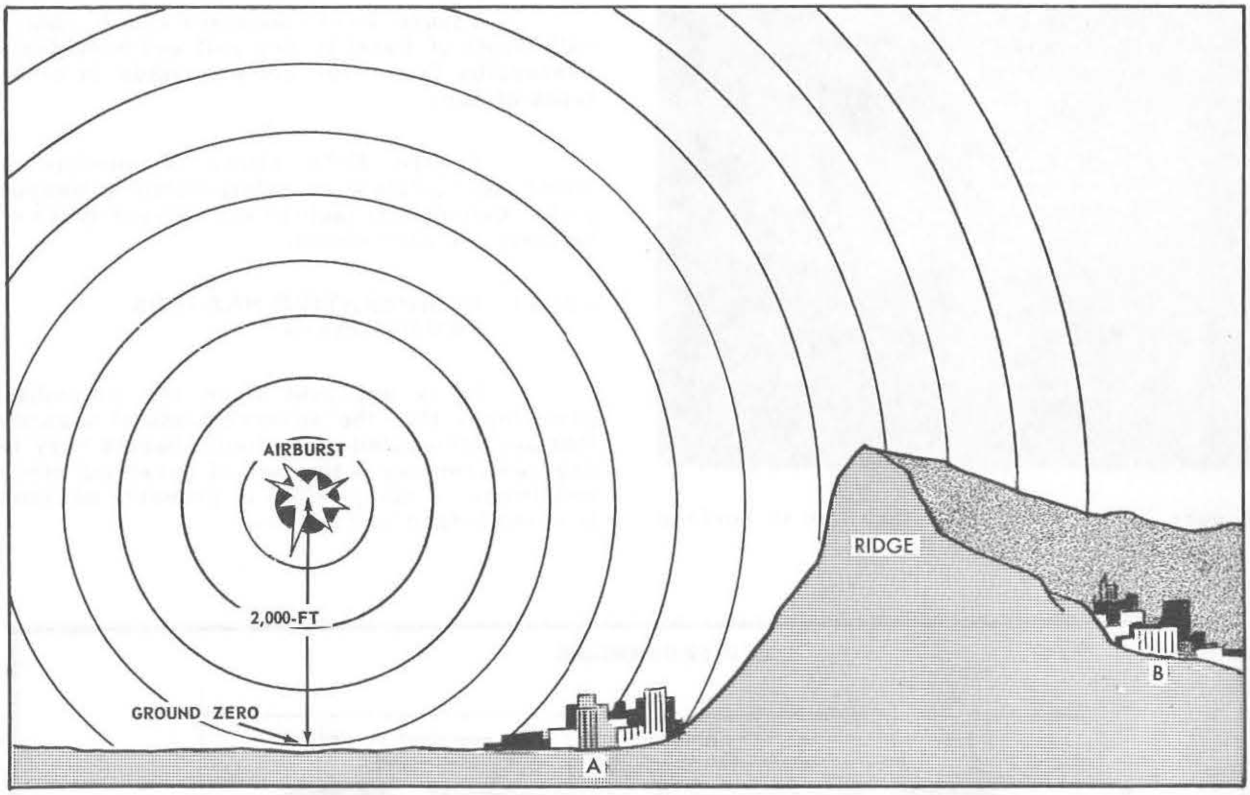


Figure 2-8. Partial Shielding Effect Produced by Unusual Terrain

2B1.11 PROBLEMS OF TERRAIN

Idealized blast, thermal radiation effects, initial nuclear radiation effects, and residual radiation patterns may all be modified by special features of terrain.

For practical purposes, however, the features must be extreme, such as the situation shown in Figure 2-8, in order to be of real benefit.

This figure shows how a steep ridge may serve as a partial shield against the blast effect of a burst. The buildings at location A are relatively close to ground zero and receive maximum impact from the shock wave for the range indicated. The shielding effect of one building upon another at A will have no effect under the conditions shown in the illustration; in fact these buildings may be worse off because of pressure that is reflected from the hill. At location B the result will be considerably different. At B the ridge provides a partial shield against the shock wave. The ridge will also furnish some shielding against thermal radiation and initial nuclear radiation.

If the burst shown in Figure 2-8 had occurred at the surface of the ground, the shielding effect of the ridge would have been greater. If the burst were a subsurface explosion, the blast hazard at B would be minimal. The real hazard would be fallout. But if the burst shown in Figure 2-8 represented a larger bomb and occurred at greater altitude, the effect of the ridge would be minimized.

2B1.12 CRATERS

A 20-kt bomb that is exploded 50 ft below the saturated surface could produce a crater approximately 270 yards in diameter and 150 ft deep. A photograph of such a crater is shown in Figure 2-9, and Figure 2-10 shows the general characteristics in cross section.

In the crater area, structures, equipment, pipelines, cables, and other underground installations will be destroyed. Transportation routes in and about the area will be impassable. Moreover, the entire area will have a high level of radioactive contamination.

Appendix E, Figure E-10, gives values for crater diameter and depth as a function of weapon yield for surface bursts in dry soil, and gives a conversion factor for the estimation of crater size in other types of soil.

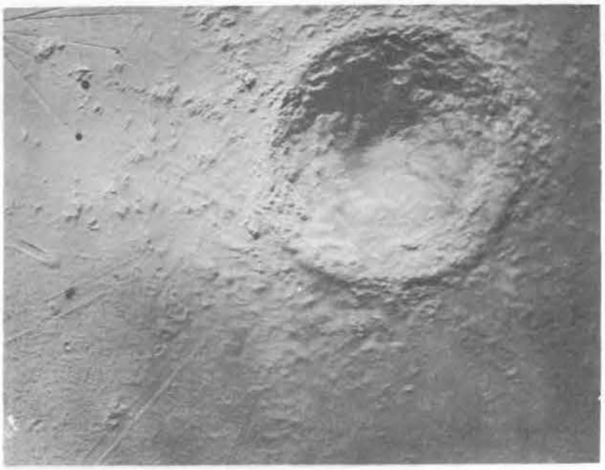


Figure 2-9. Cratering Effect Due to Surface Explosion

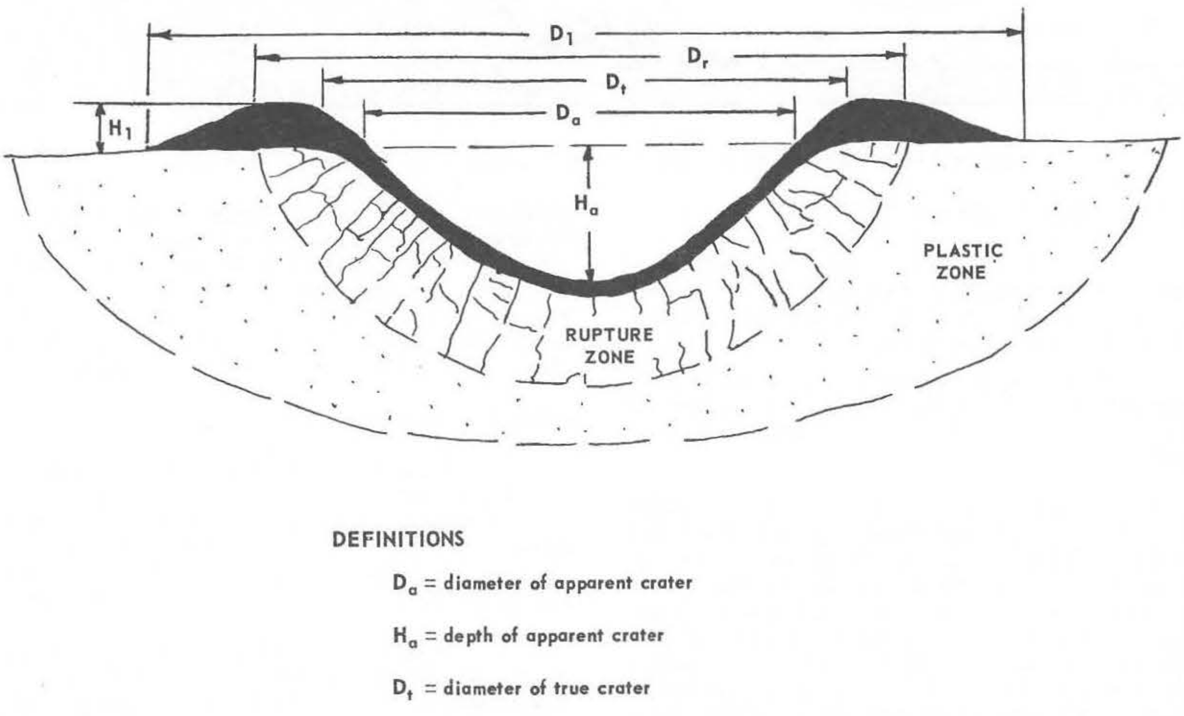
Figure E-11 compares crater radius with depth of burst in dry soil and provides a conversion factor for crater radius in other types of soil.

Figure E-12 shows dimensions of underwater craters in relationship to weapon yield. Conversion factors for various types of bottoms are also shown.

2B1.13 COMPARATIVE HAZARDS FROM BURSTS

It is apparent from the preceding paragraphs that the several kinds of hazards that are associated with atomic bursts vary in degree according to the type of burst and other conditions. A comparison of probable hazards is summarized in Table 2-1.

CRATER DIMENSIONS



DEFINITIONS

D_a = diameter of apparent crater

H_a = depth of apparent crater

D_t = diameter of true crater

D_r = diameter of rupture zone = 1.5 D_a

D_1 = diameter overall including lip = 2.0 D_a

H_1 = height of lip = 0.25 H_a

Figure 2-10. Crater Characteristics

TABLE 2-1

Comparison Between Hazards From Different Types of Atomic Bursts

Type of burst	Blast effects	Thermal radiation	Crater	Initial nuclear radiation	Base surge	Nuclear residual radiation
Airburst	Blast wave in air causes casualties and widespread destruction of physical property; also secondary fires.	Maximum thermal radiation produces casualties and widespread damage to structures and equipment; also fires.	None	Maximum effect likely to produce casualties over widespread area.	None	Not a primary hazard in most cases.
Surface burst	Blast wave in air is similar to airburst, but tends to produce overdestruction near ground zero. May also produce heavy ground shock near crater.	Similar to airburst, but more subject to containment.	Moderate to extensive crater is developed; it varies with magnitude and height of burst.	Similar to airburst	May be developed.	Likely to be much more substantial than in airburst due to larger fallout.
Underground burst	Earth shock wave of great magnitude near crater. Shock wave in air of less magnitude than in airburst or surface burst.	Largely contained by earth surrounding target center.	Moderate to extensive crater is developed; it varies with magnitude and depth of burst.	Largely absorbed by surrounding earth; induced radiation produced in earth materials by free neutrons.	Substantial; delivers residual radiation.	Contamination of considerable magnitude in and about crater.
Underwater burst	Water shock wave of great magnitude. Shock wave in air of less magnitude than in airburst or surface burst.	Largely absorbed by surrounding water.	May produce underwater crater.	Largely absorbed by surrounding water.	Substantial; delivers residual radiation.	May be considerable contamination on nearby land areas.

NOTE: Total bomb energy release is assumed to be comparable in all cases.

2B2.01 PATHOGENS

Biological warfare agents consist of living germs, toxins that are derived from living germs, and certain plant-growth regulators. They can be used against personnel, cultivated plants, and domesticated animals; they are also employed in some combinations that are designed to delay defense production and render the population incapable of effective resistance. Biological agents do not destroy physical property. However, in an area that is heavily contaminated by BW agents, the effective use of physical properties would be restricted. The number of potential BW agents that are currently acceptable in terms of military requirements is limited. Probabilities point in the direction of some of the less well-known pathogens that have not been a primary concern of the nation under attack because they had been confined to other areas of the earth. There is also the possibility of developing special genetic varieties of well-known pathogens that would be resistant to existing defenses.

2B2.02 GROUPS OF POTENTIAL BW AGENTS

The potential BW agents belong to a number of groups--some are plants, some animals, and some are the poisonous products of plants and animals. In addition, synthetic chemicals are available for use against plants. The most important groups are described in the following paragraphs.

1. VIRUSES. The viruses are the smallest living organisms and can be viewed only with an electron microscope. They grow only in living cells and cause diseases of man, domestic plants, and animals.

Viruses are responsible for a number of human diseases, including chicken pox, common colds, dengue, measles, hepatitis, infantile paralysis, influenzas, lymphocytic choriomeningitis, mumps, phlebotomus fever, psittacosis, rabies, smallpox, trachoma, virus pneumonia, and yellow fever.

2. RICKETTSIAE. The rickettsiae are larger than viruses and smaller than most bacteria. They will grow within or between living cells but rarely in media that contain body fluids. The larger rickettsiae may be seen with an ordinary light microscope. They cause such diseases as endemic typhus fever, epidemic typhus fever, rickettsialpox, scrub typhus, South African tick-bite fever, spotted fever, and Q-fever.

3. BACTERIA. The bacteria are unicellular plants and can usually be grown in the absence of living cells. They can not be seen without a microscope. They cause such diseases as anthrax, bacillary dysentery, botulism, bubonic plague, diphtheria, erysipelas, gas gangrene, gonorrhea, leprosy, lobar pneumonia, meningococcus meningitis, paratyphoid fever, scarlet fever, tetanus, tuberculosis, tularemia, typhoid fever, undulant fever, and whooping cough.

4. PROTOZOA. The protozoa are a group of simple animals. Some of the common diseases of livestock, such as coccidiosis, are protozoan diseases. In the human body protozoa cause malaria, African sleeping sickness, amoebic dysentery, Chaga's disease, and different types of Leishmania infections.

5. FUNGI. The multicellular fungi are simple achlorophyllic plants that have no true stems, leaves, or roots. They range in size from microscopic yeasts to molds and mushrooms that can be seen with the naked eye. They are grown with relative ease in the absence of living cells.

A number of human infections, such as actinomycosis, favus, so-called "ringworm" (athelete's foot), and San Joaquin Valley fever, are caused by fungi, and so are some diseases of livestock. But as BW agents, fungi are more likely to be used against crop plants, because there are many fungi that cause devastating plant diseases.

6. TOXINS. Toxins include a variety of substances that are produced by quite diverse types of plants and animals, including some of the pathogens. Successful synthesis of potentially useful toxins might bring them to the forefront as possible weapons. Toxins can not reproduce themselves, hence their effect in attack is limited to the toxin that is actually delivered at the target. Representative toxins are tetanus toxin, botulinum toxin, diphtheria toxin, and staphylococcal toxin. Botulinum toxin is the most toxic substance known.

2B2.03 CLASSIFICATION

Biological warfare agents may be classified in several ways, for example, by type, object of attack, severity of effect produced, persistency, virulence, communicability, and tactical use. Such classifications are, of course, relative, often overlap, and are subject to change. From the military point of view, the important classifications of biological

agents are virulence, communicability, and persistency.

1. TACTICAL AND STRATEGIC EMPLOYMENT. From the standpoint of tactical and strategic employment, pathogens may be described as (a) antipersonnel, (b) antianimal, or (c) anticrop. There is considerable overlapping among these three categories. For example, an ideal BW agent would have equally adverse effects upon domestic animals and man.

2. VIRULENCE. Another type of classification relates to the virulence of potential BW agents. An agent may be lethal or merely debilitating. The problem of virulence is complex because the relative virulence of a given species of pathogen is subject to variation, and the same organism may vary with environmental conditions, relative humidity, rainfall, and temperature. It is now possible to develop particularly virulent strains by taking advantage of natural or induced mutation and employing the techniques of genetic selection.

3. COMMUNICABILITY. From the military standpoint, widespread transmission of a pathogen from person to person, which might result in an epidemic of disease, would be a bonus effect. The intended purpose of a BW agent, however, is not to produce such a bonus effect, but to directly infect the personnel with whom it is brought in contact.

Pathogens that can be transmitted readily by direct and/or indirect contact present definite advantages as agents.

5. PERSISTENCY. The persistency of BW agents is also an important consideration in the selection of an agent. The persistent agents will remain effective for a long period of time and can be very much more resistant to the elements than even the most persistent chemical agents.

2B2.04 DEFENSE

The human body possesses a number of natural defenses against invasion by pathogens. These, as a group, constitute the so-called resistance to disease. Defense against biological agents includes these natural defenses, together with early detection and identification of BW agents, physical protection, pest control, sanitation, hygiene, quarantine, immunization, and treatment. A discussion of several of these defensive measures is contained in the following paragraphs.

1. NATURAL DEFENSES. The average individual, even when apparently in good health, has within his body a host of tiny organisms. But these do not, ordinarily, produce the clinical symptoms of a disease. To do that, pathogens must first gain entrance to human tissues, and they must then reproduce and become sufficiently numerous to constitute an active infection. Human beings are born with some immunities and are in the process of acquiring others throughout their lives. Some immunities result from having active cases of disease, and some result from subclinical invasions. Various immunities may be conferred by vaccination and inoculation. For a few germ diseases, however, little or no immunity appears to have been developed.

2. CHEMICAL DEFENSES. Another line of defense involves the employment of chemical substances such as (a) the antiseptics and disinfectants that prevent infections and (b) the drugs that inhibit or kill pathogens that have gained access to human tissues. The most effective use of drug defenses results when the invading pathogens are detected and identified promptly. This is the reason why provision for such detection and identification is so important in defense planning.

3. PREVENTIVE INOCULATION. Preventive inoculation is strictly in the medical field and will be discussed only briefly here. If a suitable vaccine is available, preventive inoculation will give a good measure of protection against infection by a biological agent. However, there are effective vaccines for only a few of the BW agents that might be used; and even when a vaccine is available, it takes time to develop resistance to the agent. Most available vaccines, although effective against ordinary exposure, may be relatively ineffective against extraordinarily high concentrations, such as might be experienced in BW attacks.

Although mass inoculation of the civil population would be a gigantic task even if it were limited to special areas of the country, it should prove very useful in preventing or reducing casualties. Mass immunization of the services, on the other hand, presents no great administrative difficulties. The technical and administrative problems in connection with inoculation are being studied.

4. INTELLIGENCE. Even though detection devices may be operating, the initial warning may be given by sources of intelligence. In time of war, intelligence is obtained from special organizations such as the Naval Intelligence Service, the Central Intelligence Agency, the State Department, and the Federal Bureau of Investigation. In the field, information may be acquired from underground

organizations, refugees, and the local population. Information may also be gleaned from captured enemy documents, such as orders, health records, memoranda, correspondence, and manuals, as well as from captured munitions, biological materials, defensive and offensive equipment, blood tests of prisoners of war, and aerial reconnaissance. These are but a few of the possible sources of information that may be used to determine the actual or contemplated enemy use of biological agents in time of war.

5. PHYSICAL PROTECTION. The presence of pathogenic microorganisms on, or within, the body of an individual does not assure that infection is an inevitable result. Nevertheless, it seems likely that the chances of possible infection would be greater in the presence of larger numbers of such organisms. It is desirable, therefore, to prevent all such disease-carrying organisms from coming into direct contact with the body. This can be accomplished by means of certain physical methods of protection such as protective masks, protective clothing, and group shelters. The ultimate goal of physical protection is the absolute exclusion of pathogens from the respiratory passages and from the exposed body surfaces.

2B2.05 CONTAMINATION

After an attack in which BW agents were used, the pattern of contamination would depend to a considerable extent on (a) the type of agent or agents employed and (b) the manner of the employment. Vectors, for example, would be important for spreading contamination by some agents but not by others. Spore formation by pathogens, with resulting persistency, would be predictable for some agents but not for others. Some living BW agents would not be expected to remain viable for any great length of time unless they penetrated the tissues of acceptable hosts, whereas others might persist outside of host tissues for a comparatively long time. The residual hazard to personnel would vary further because some pathogens are commonly conveyed by contact, others in food and drink, and still others through the agency of vectors.

Covert attack that involves BW agents is a real possibility. To contaminate water supplies, for example, an agent or agents could be introduced into a reservoir or other source of supply. More probably they would be pumped into the water mains at some location that was available to the saboteur. The latter action would avoid the possibility that the BW agents might be detected and/or destroyed in the process of water purification. Sodium thiosulfate or some other chlorine-reducing substance might also be pumped into the mains to render existing chlorine residuals ineffective, and thus assure the survival of the pathogens. To even determine the necessity for decontamination, early detection and identification of agents must be made. The amount of effort and materials required for decontamination are so large that it will not usually be feasible to undertake extensive decontamination without some clear-cut indication of the identity of the agent and the extent of contamination.

2B3.01 CLASSIFICATION

The war gases are one group of chemical agents that are available for use in modern warfare. Other groups include the chemical smokes and the incendiaries. Chemical agents are classified according to their (a) physical state, (b) tactical uses, and (c) physiological actions.

1. PHYSICAL STATES. Under ordinary conditions of temperature and pressure, various so-called war gases can exist in the gasious, liquid, or solid state. In the past it was also customary to classify agents in terms of their persistency. This classification has been discarded because persistency varies over a wide range, depending on temperature and moisture (Table 2-2).

From the standpoint of decontamination, it is obvious that only the more persistent agents will be of any concern.

2. TACTICAL USES. From the tactical standpoint, war gases are classified as casualty gases and harassing gases. As the name indicates, casualty gases are those that are capable of producing death or serious incapacitation of personnel. Harassing gases produce only temporary, and sometimes partial, incapacity. The harassing gases and casualty gases may be used in combination. A tactical use may include a harassing gas of the vomiting type to induce personnel to remove their masks, and a casualty gas to inflict the serious damage.

3. PHYSIOLOGICAL ACTIONS. With respect to physiological actions, war gases include types that are classified as (a) choking gases, (b) blister gases, (c) blood gases, (d) nerve gases, (e) vomiting gases, and (f) tear gases.

2B3.02 EMPLOYMENT

War gases may be employed to (a) cause casualties, (b) deny the use of an area, and (c) harass an enemy. The element of surprise is an important factor in the use of war gases as a means of causing casualties, because the prompt employment of protective devices would nullify their effects. Usually, war gases that are designed to cause casualties have a high rate of toxicity and very limited persistency. The objective would be to develop a high concentration of the gas as rapidly as possible and within a limited target area. If gas were employed by an enemy to deny the use of an area, a persistent agent would be used. Terrain, however, can not be denied to a determined enemy by depending solely on persistent agents. Even though troops are not protected, they can be ordered to secure the area and then replaced after the decontamination of essential positions. This would be done with the knowledge that there would be a large number of casualties.

Table 2-2 lists a number of war gases that are currently considered to be of major interest, along with their physical state, actions, and persistency.

Table 2-2 indicates the characteristic odor of each gas, but odor should not be relied upon as a means of detection during or following an attack.

2B3.03 WAR GASES OF PRIMARY IMPORTANCE

Currently, only two classes of war gases are considered in disaster control planning. They are (a) the group of vesicants, principally distilled mustard HD, and (b) the nerve gases GA, GB, and V. The characteristics of gas V are classified and are not included in Table 2-2.

1. BLISTER AGENTS. All of the blister agents are persistent, and all may be employed as casualty agents in the form of colorless gases and liquids.

Blister agents include the mustards (HD, HN-1, HN-2, and HN-3) Lewisite (L), mustard-Lewisite mixture (HL), and a group of dichloroarsines (ED, MD, and PD).

Distilled mustard gas or liquid produces no immediate symptoms among personnel. Usually, the symptoms appear 4 to 6 hours later, whereupon the eyes begin to smart, the skin may become red and blistered, and the victim may cough and vomit. The rate of detoxification is very low, which means that even small, repeated doses are cumulative in their effects. Gas HD acts first as a cell irritant and than as a cell poison. Common effects are inflammation of the eyes; reddening, blistering, or ulceration of the skin; and inflammation of the nasal passages, throat, trachea, bronchi, and lung tissues. The agent gains entrance through inhalation, skin absorption, and contact with the eyes.

TABLE 2-2

Characteristics of War Gases

Name and symbol	Odor	Tactical and physiological classifications	State at 68°F and atmospheric pressure	Effect on body	Persistency
Distilled mustard (HD)[1,4]	Like garlic or horseradish	Casualty gas Blister gas	Colorless to pale yellow liquid	Injures eyes and lungs; blisters skin	Summer: 3 or 4 days in open; 1 week in woods Winter: several weeks
Mustard (H)[1]	Like garlic or horseradish	Casualty gas Blister gas	Dark liquid	Injures eyes and lungs; blisters skin	Summer: 3 or 4 days in open; 1 week in woods Winter: several weeks
Nitrogen mustard (HN-1)[1]	Odorless to faint fishy	Casualty gas Blister gas	Dark liquid	Injures eyes and lungs; blisters skin	Summer: 3 or 4 days in open; 1 week in woods Winter: several weeks
Mustard T-mixture (HT)[3]	Like garlic or horseradish	Casualty gas Blister gas	Clear to pale yellow liquid	Injures eyes and lungs; blisters skin	Summer: More persistent than HD or H Winter: More persistent than HD or H
Lewisite (L)[1]	Irritating, unpleasant; faintly like geraniums	Casualty gas Blister gas	Dark, oily liquid	Injures eyes, blisters skin	Summer: 1 day in open; 2 or 3 days in woods Winter: 1 week or longer
GA[1]	Faintly fruity, sweetish	Casualty gas (fast acting) Nerve gas	Colorless to brown liquid	Causes blurred vision with pinpointing of pupils, muscle and eye spasms, difficult breathing, tight chest, salivation, mental confusion, convulsions	Summer: 10 minutes to 24 hours Winter: 10 minutes to 24 hours
GB[1,4]	Odor scarcely detectable; none when pure	Casualty gas (fast acting) Nerve gas	Colorless liquid	Causes blurred vision with pinpointing of pupils, muscle and eye spasms, difficult breathing, tight chest, salivation, mental confusion, convulsions	Summer: 10 minutes to 12 hours Winter: 10 minutes to 12 hours Longer in shell holes
Hydrocanic acid (hydrogen cyanide)[2]	Like bitter almonds	Casualty gas (fast acting) Blood gas	Colorless liquid	Causes dizziness, convulsions, paralysis, coma, collapse	Summer: 1 to 10 minutes Winter: several hours
Cyanogen chloride (CK)[2]	Somewhat like AC, but irritating	Casualty gas (fast acting) Blood gas	Colorless gas	Injures lungs; causes convulsions, paralysis, respiratory arrest	5 to 10 minutes
Phosgene (CG)[2]	Like new mown hay or ensilage	Casualty gas (delayed action) Choking gas	Colorless gas	Injures lungs, causing accumulation of fluid	Summer: 5 minutes in open; 10 minutes in woods Winter: 10 minutes in open; 20 minutes in woods

[1]Requires protective clothing and mask. [2]Requires protective mask. [3]Decomposes below boiling point at normal atmospheric pressure. [4]Presently a U. S. standard agent.

The nitrogen mustards are also delayed-action casualty gases. Detoxification does not occur--hence effects are cumulative. These effects are similar to those produced by distilled mustard, but very low concentrations of HN-1 and HN-2 produce eye irritation. Injury to the respiratory tract may be followed by fever, labored breathing, and bronchopneumonia. The nitrogen mustards may also produce lesions in the intestines, which are associated with severe diarrhea and hemorrhage. These agents gain entrance to the body through inhalation and skin absorption.

Lewisite (L) is an arsenical gas that has only moderately delayed action. The body does not detoxify, but detoxification can be induced through intramuscular injection of BAL in oil. Lewisite produces severe eye damage and blistering of the skin. It is also a toxic lung irritant and a systemic poison, and when it is inhaled in quantity, it may produce fatality within 10 minutes. Entrance to the body is made in the manner used by the preceding blister agents, and countermeasures include masking and the wearing of protective clothing.

2. NERVE AGENTS. The nerve gases may be used in colorless, gaseous form, or as colorless or brown liquids. In general, they are moderately persistent agents (Table 2-2). They are relatively difficult to detect promptly. Nevertheless, early detection is vital because the nerve gases are quick casualty producers, and for this reason, they will prove to be the most effective of all CW agents.

The primary physiological effect of the nerve gases that belong to the G-agent series (GA and GB) is upon the nervous system, followed by impairment or failure of body functions. Early symptoms of exposure to nerve gases include contraction of the pupils of the eyes and accompanying impairment of vision, followed by chest pains, headache, twitchings, rapid breathing, and stomach cramps. Lethal exposure terminates with convulsions, paralysis, and death. Because of their potentially great importance, the early effects of nerve gases are diagrammed in Figure 2-11, and their effects are compared in Table 2-3. The G-agents may be inhaled, ingested, or absorbed through the skin.

There are some newer type agents that are relatively nonvolatile nerve gases. These agents are inherently about twice as toxic as the older nerve agents via the inhalation route. Percutaneously, the newer agents are several hundred times more toxic than the older ones.

Developments are currently underway to improve the present methods of dissemination to further increase the effectiveness of these newer agents.

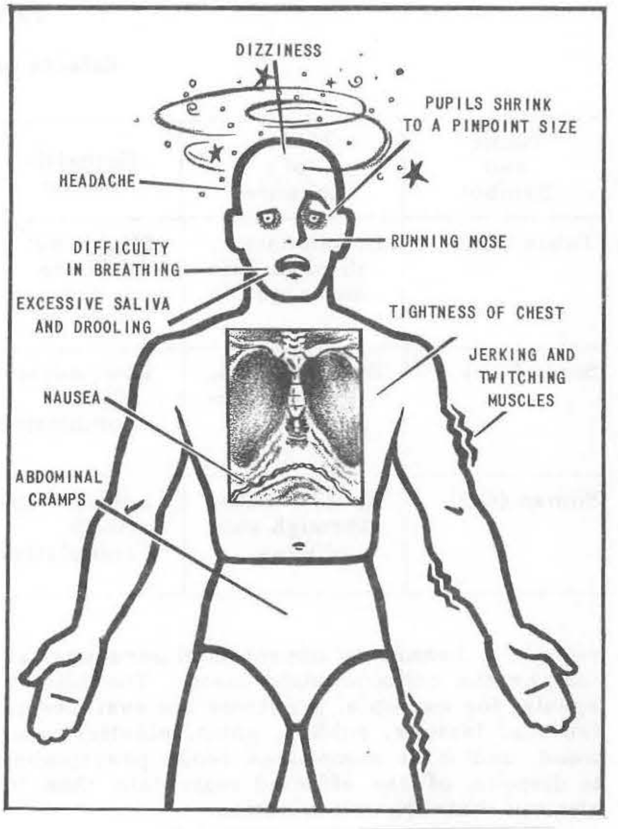


Figure 2-11. Early Symptoms of Exposure to Nerve Gases

2B3.04 CHEMICAL CONTAMINATION

Only the more persistent agents will require decontamination. It will usually be preferable to wait and allow the less persistent agents to vaporize. If persistent agents have been employed on a large scale, the resulting contamination will affect clothing, personnel, equipment, supplies, and all objects except those in gasproofed shelters that have maintained their structural integrity during attack. An ordinary, closed building gives (a) some protection against liquid sprays and (b) somewhat less protection against agents in gaseous form, as long as it remains closed. Personnel, however, should not stay unprotected (without masks or collective protectors) in an unsealed building, because as long as an agent cloud surrounds the structure, the agent in vapor or aerosol form will leak in. As soon as the concentration outside is reduced by natural phenomenon below that inside, the building should be vacated or thoroughly ventilated.

Terrain, structures, clothing, equipment, supplies, and any other substances that have been contaminated by persistent agents

TABLE 2-3

Effects of Nerve Gases

Name and Symbol	Mode of entrance	Detoxification	Rate of action	Basic physiological effects	Persistency
Tabun (GA)	By inhalation, through skin and eyes	Slight, but definite	Death within 15 minutes after lethal dose	Upon nervous system, causing vasoparesis	Moderately persistent
Sarin (GB)	By inhalation, through skin and eyes	Low, essentially cumulative	Death within 15 minutes after lethal dose	Upon nervous system, causing vasoparesis	Moderately persistent
Soman (GD)	By inhalation, through skin and eyes	Low, essentially cumulative	Death within 15 minutes after lethal dose	Same effect, but lethal in lower concentrations	Less persistent than Tabun and Sarin

remain a hazard to unprotected personnel as long as the contamination lasts. The blister agents, for example, penetrate the surfaces of fabrics, leather, rubber, paint, plastics, and wood, and it is sometimes more practicable to dispose of the affected materials than to attempt their decontamination.

Many of the chemical agents combine with water to form acids that have a corrosive effect upon metals, leather, fabrics, and paints. This corrosive action is most evident when the agent has been used in liquid form, but some equipment is likely to be destroyed even though the agent is employed as a gas.

As long as the contaminating agents persist within an area or building in significant amounts, they are a hazard to personnel and prevent the effective use of equipment.

2B4.01 SCREENING SMOKES

The physical characteristics of a number of screening smokes are shown in Table 2-4. When generated, such smokes consist of liquid or solid particles in air, which reflect and absorb light and usually limit vision. They may be used to conceal defense positions and the movements of attacking troops. The use of a smoke generator to produce screening smoke is shown in Figure 2-12.

Primarily, screening smokes are not intended to produce casualties; heavy concentrations of some of them, however, may cause irritation of the eyes, nose, throat, and lungs unless personnel are masked. The possibility that screening smokes are being used to hide the presence of casualty-producing war gases should always be considered.

2B4.02 INCENDIARIES

Incendiary materials include thermite, thermite magnesium, white phosphorus (which also produces a smoke), and a number of incendiary oils. These materials are used in a variety of ways, often for the purpose of setting fires that will damage or destroy material, equipment, and structures, but also to cause casualties, incite panic, and induce demoralization. The general nature of the incendiary substances is shown in Table 2-5. Figure 2-13 shows napalm-filled bombs being used to spread fire and destruction in a modern city.

Tactical or strategic use of incendiary bombs often depends upon starting a number of fires that will merge in time to produce a widespread conflagration. Compared with thermite-magnesium combinations, thickened fuel has a lower burning temperature and a shorter burning time, which are sufficient to ignite readily combustible materials and structures, but are not adequate to ignite heavy and medium construction or large equipment.

Figure 2-12. Smoke Generator

TABLE 2-4

Properties of Screening Smokes

Screening smoke and symbol	State at 20°C (72°F)	Rate of hydrolysis	Odor	Toxicity	Physiological action	Protection required	Stability	Decontamination	Munitions suitable for use	Means of detection
Titanium tetrachloride ($TiCl_4$FM)	Heavy, colorless liquid	Hydrolyzes instantly	Acrid	Smoke not toxic	Liquid corrosive to skin; smoke causes mild burning sensation	None for ordinary concentrations; protective mask for dense smoke; rubber gloves for liquid	Stable in absence of moisture	Alkaline solid or solution	Artillery shell, mortar shell, spray tanks, bombs, special munitions	M11 smoke detector kit
Sulfur trioxide-chlorosulfonic acid solution (FS)	Liquid	Hydrolyzes instantly	Acrid	Smoke not toxic	Similar to FM, but more corrosive	Same as FM	Stable in absence of moisture	Alkaline solid or solution	Same as above	Same as above
HC mixture (HC)	Solid	$ZaCl_2$ hydrates very rapidly	Slightly acrid	Not toxic except in high concentration	Inhalation of dense smoke may produce symptoms of zinc poisoning	None for ordinary concentrations; protective masks for dense smoke	Adequate; may decompose if wet	None required	Grenades, candles, pots, air bombs, artillery shell	Same as above
White phosphorus (P_4,WP, or PWP)	WP, pale yellow, waxy solid PWP, finely divided WP in gel of rubber and xylene	None, oxidizes	Similar to matches	Smoke not toxic	Burning WP or PWP causes slow-healing burns; vapors (not smoke) very poisonous, causes bone decay	None for ordinary concentrations; flame proof clothing for burning particles	Stable in absence of air	Water or $CuSO_4$ solution stops burning	Grenades, artillery or mortar shells, bombs	Same as above
Fog Oil	Liquid	None	Similar to kerosene	Nontoxic	None	None	Stable	None required	Generators, grenades, pots	None required

Figure 2-13. Fires Produced by Napalm-Filled Incendiary Bombs

TABLE 2-5

Composition and Symbols of U. S. Incendiary Agents

Name and symbol	Use	Composition
Incendiary mixture (PT 1)	Bombs	Petroleum oil, magnesium waste, and isobutyl methacrylate polymer as a thickener
Incendiary oil (IM)	Bombs	Isobutyl methacrylate and gasoline
Incendiary oil (NP)	Bombs Flame throwers	Gasoline and (napalm) thickener M1
Incendiary oil (OT)	Bombs Flame throwers	Gasoline and (octal) thickener M3
Incendiary oil (NP 2)	Bombs	Gasoline and (antiagglomerated napalm) thickener M2
Thermite (TH 1)	Bombs Grenades	Thermite
Thermate (TH_2 and TH_3)	Bombs Grenades	Thermate

CHAPTER 3. CASUALTIES AND DAMAGE FROM ABC ATTACK

PART A. CASUALTIES

Section 1. NUCLEAR WEAPONS

3A1.01 RESULTS OF BLAST

1. PRIMARY EFFECTS ON PERSONNEL. In general, a nuclear blast causes unprotected personnel in the area to suffer a state of shock and injuries that include bruises, cuts, fractures, and concussions. The translational forces of the blast will throw personnel against walls and other objects, thereby causing many injuries. An individual who is hurled at a velocity of 12 ft per second will receive injuries in 50 percent of the instances when solid impact occurs. At a velocity of 17 ft per second, the individual will be killed in 50 percent of the instances when solid impact occurs.

Primary blast injuries are those that result from shock wave effects upon the human body. Primary blast alone is not likely to be a major factor in the production of casualties, because of the unusual resistance of the human body.

A blast pressure of about 100 psi is required to cause severe injury to the human body. At that pressure other effects would almost surely be more damaging to personnel unless they were in shelters that provided good shielding from the radiation effects.

The anticipated effects of blast pressures upon the human body include injuries to the eardrums, lungs, stomach, and intestines, any one of which might be accompanied by an internal hemorrhage. An overpressure of 2 to 5 psi has been known to rupture eardrums; 15 to 25 psi, however, is considered the critical range for eardrums.

2. SECONDARY EFFECTS ON PERSONNEL. Many casualties may be expected as the result of secondary, or indirect, blast effects. These effects are related to structural damage, because casualties are often caused by the collapse of structures and by the missile effects of fragments that are hurled about. In fact, missile effects are likely to be a principal factor in the production of casualties, both indoors and outdoors. Appendix E, Table E-2, includes data on missile density and velocity. Windows, for example, are likely to be broken under overpressures of 0.5 to 1.0 psi, and a pressure range of 2 to 5 psi will produce stilettoes of glass that are capable of penetrating the abdominal wall.

Blast effects cause extensive secondary fires, thereby creating additional casualties.

Airbursts from nuclear bombs that are detonated at optimum altitudes can therefore be expected to produce secondary blast casualties at the following ranges from ground zero.

Bomb yield	Miles from ground zero
20 kiloton	2.0
50 kiloton	2.7
100 kiloton	3.4
160 kiloton	4.0
1 megaton	7.4
5 megaton	12.6
10 megaton	15.9
20 megaton	20.0

3A1.02 CASUALTIES FROM THERMAL RADIATION

1. INJURIES TO EYES.

The intense flash of light that accompanies a nuclear burst may produce flash blindness, even at a range of several miles. The condition amounts to only temporary incapacity, because the eye will overcome flash blindness in about 15 minutes in the daytime and in about 45 minutes at night. Special glasses have been developed for the use of pilots who are involved in the delivery of nuclear weapons.

The more serious damage to the eyes are retinal burns that are permanent in nature. About 3 cal/sq cm of thermal energy on the retina will produce severe burn; this effect when produced by large-yield weapons will be evident for as far as 42 miles.

2. BODY BURNS. Direct burns to the body will undoubtedly result in a large number of casualties. Not only is the level of thermal energy important in the production of burns but the length of time of exposure is important also. For example, a total energy of 5 cal/sq cm will be received from a kiloton weapon in a much shorter period of time than the same total energy from a megaton weapon, thus causing more severe burns. Figure 3-1 indicates the distances from ground zero versus weapon yield where first-, second-, and third-degree burns may be expected to unprotected personnel.

Burns may also be classified according to the manner in which they are sustained. Thus, primary burns (also called flash burns) are the results of direct thermal radiation from a bomb explosion, whereas secondary burns are produced by fires that follow in the wake of an explosion.

Light-colored, loose-fitting clothing provides a highly desirable protection against primary burns at moderate and long range, and so does any kind of structural shielding. But if the shielding is not substantial, casualties will occur as a result of blast effects that cause structural collapse.

If 100-percent-clear atmosphere were possible, thermal radiation would travel in straight lines, and only surfaces that faced the burst would receive primary burns directly. For all practical purposes, the atmosphere is never perfectly clear. As a result, some refracted radiation will reach all surfaces. Reflected thermal radiation, however, usually produces less severe burns than those that result from direct exposure. Therefore, a part of a body that is shielded by a tree or any other solid object might escape burn injuries, while an exposed part of the same body might be damaged.

3. SECONDARY FIRES. Fires may start as the result of a nuclear detonation, thus causing many casualties that are due to secondary burns. These fires may spread rapidly and develop a fire storm. If so, casualties are likely to be high in the affected area, because the avenues of escape are limited. At Hiroshima and Nagasaki, burns accounted for about one half of the fatalities and three fourths of the injuries.

Because secondary burns are incident to fires, the range at which they may occur usually coincides with the range at which fires are started and structures suffer at least moderate damage. In addition, there is the possibility of a fire spreading to areas where structural damage from the explosion has not occurred.

The scaling rule for direct thermal radiation is discussed in paragraph 2B1.03 and illustrated in Figure 2-2.

3A1.03 CASUALTIES FROM NUCLEAR RADIATION

1. TYPES AND EFFECTS OF DOSES. From a disaster control standpoint, the most important nuclear radiation is gamma radiation. Beta particles and neutrons are likely to be much less important. Neutrons, however, can be very important near ground zero for low-yield weapons. An individual may suffer (a) an acute exposure, which means that he receives a dose within a short interval of time (arbitrarily set at 24 hours) or (b) a chronic exposure, which means that he receives a dose that is accumulated over a longer interval. With regard to chronic exposures, the key fact is that doses of nuclear radiation and their effects are cumulative even though there is a degree of recovery in time.

Either type of dose, when of sufficient magnitude, produces radiation sickness, with effects that range from relatively mild and temporary manifestiations to fatality.

2. SOURCES OF NUCLEAR RADIATION. Doses of nuclear radiation may be received (a) in the form of initial radiation at the time of a burst and/or (b) through exposure to residual radiation or radioactive contamination after a burst. The source of nuclear radiation is of concern to the disaster control officer, because the dose of initial radiation received must be subtracted from the total dose that he estimates he can allow his organization to receive. All planning and operations that follow an attack must be designed to keep exposure of personnel to a minimum that is consistent with the demands at the time. If this is not done, casualties will result, personnel will be lost to the recovery effort, and an added burden will be placed on medical facilities.

Table 3-1 illustrates the effects upon personnel of doses that are received over relatively extended periods of time. Note that a dose of 45 r received in the course of one day produces a probable mortality rate of 50 percent; but if the dose is accumulated over a period of a week, the anticipated mortality rate drops to 15 percent.

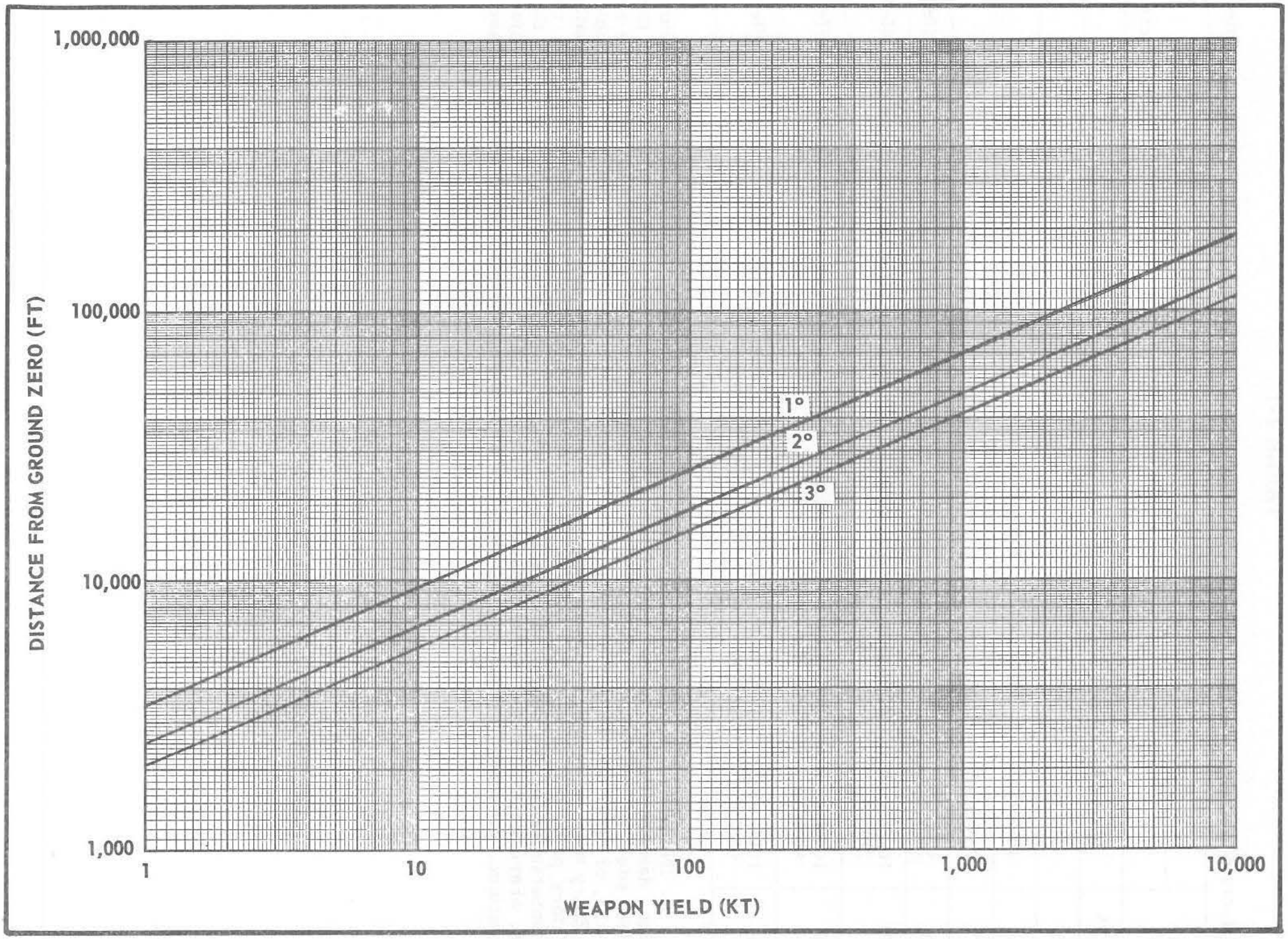


Figure 3-1. Skin Burns as a Function of Weapon Yield and Distance from an Airburst

TABLE 3-1

Effects of Various Doses of Nuclear Radiation Received Over Varying Periods of Time

Dose (r)	Time					Late effects
	1 day	3 days	1 week	1 month	3 months	
0 to 75	0% sick					None
100	2% sick	0% sick				None
125	15% sick	2% sick	0% sick			None
150	25% sick	10% sick	2% sick	0% sick.		None
200	50% sick	25% sick	15% sick	2% sick	0% sick	Some late effects
300	100% sick 20% die	60% sick 5% die	40% sick	15% sick	0% sick	Some late effects
450	100% sick 50% die	100% sick 25% die	90% sick 15% die	50% sick	5% sick	Some late effects
650	100% sick 95% die	100% sick 90% die	100% sick 40% die	80% sick 10% die	10% sick	Some late effects

3. INTERNAL RADIATION. Internal radiation damage occurs when radioactive particles such as plutonium, strontium 90, iodine 131, or other fission products enter the body. Entry may be by way of the mouth, the respiratory passages, or wounds. The radioactive substances become deposited in various tissues, where they continue to emit radiations that continue, in some instances, over long periods of time. Plutonium and strontium are particularly pernicious, because they tend to become concentrated in the bones. The symptoms of radiation sickness from internal sources may not be apparent for months or even years. For this reason, internal radiation will not have any direct effect on the recovery effort, but ultimately the injurious effects may be expected to manifest themselves.

3A2.01 NATURE OF BW EFFECTS

Because the effects that are produced by different potential BW agents vary considerably, the enemy has a wide choice of agents to produce the desired results, which may vary from the creation of widespread incapacity to the production of fatalities. The BW agent that is chosen is not necessarily the one that will produce the greatest number of fatalities. It may be the agent that will present the greatest element of surprise and against which the opponent's defenses are incomplete or nonexistent. A few possibilities are suggested here to illustrate this point.

1. ANTHRAX. Anthrax is normally a disease of stock animals, but it can be contracted by workers who handle infected meat and hides. Human susceptibility, however, appears to be quite general. There are three types of the disease in man: (a) a cutaneous (skin) form that has an untreated mortality rate of about 25 percent, (b) a pulmonary (lung) form, and (c) an intestinal form. Types (b) and (c) have an untreated mortality rate of about 100 percent. Immunization and drug defenses do not presently afford a full measure of protection.

2. COCCIDIOIDOMYCOSIS. Coccidioidomycosis, which is also known as valley fever and San Joaquin fever, is a subtle disease, and passes unrecognized so often that mortality rates are unknown. Sometimes it produces infection of the lungs with symptoms that are similar to those of influenza, and sometimes it becomes a rapidly fatal systemic infection.

3. ENCEPHALITIS. Several types of encephalitis are produced by a group of viruses, and each type is characteristic of a particular area of the earth's surface. Vectors would normally be essential to the transmission of encephalitis and already exist in some areas. It is possible, of course, to transmit this disease in a BW attack in aerosols without the use of vectors. The exact mortality figures are not known but are believed to be as high as 60 percent in one type and as low as 5 percent in another.

4. GLANDERS. Glanders is another animal disease that is communicable to man in either acute or chronic form. The chronic form can be dealt with by surgical means. The acute form has an untreated mortality rate of 100 percent, while the mortality rate in the chronic form is about 50 percent. Effective immunization and drug treatment have not been developed.

5. TULAREMIA. Tularemia is a disease that does not have a very high untreated mortality rate, but it is an effective producer of incapacitation. A variety of wild animals will act as reservoirs for the infection. Susceptibility appears to be general, although an attack of the disease confers immunity. Drug defenses are reasonably effective against tularemia, and without their use, this disease is likely to produce a long period of disability.

6. OTHER DISEASES. Other diseases that have relatively high untreated mortality rates are cholera (50 percent), bubonic plague (30 to 60 percent), pneumonic plague (90 to 100 percent), Rocky Mountain spotted fever (20 to 60 percent), scrub typhus (up to 50 percent), and typhus (10 to 80 percent). Conversely, infectious hepatitis has an untreated mortality rate of less than 0.5 percent, and Q-fever a rate of 0 to 4 percent. Agents like the last two would be relied upon mainly to produce incapacitation of personnel.

It should be emphasized that the rates cited here are untreated mortality rates. Even for diseases against which defenses are less than satisfactory, it is highly probable that the mortality rates would be substantially lower under treatment. During a successful BW attack, however, sufficient medical personnel, drugs, and facilities might not be available for adequate treatment.

3A2.02 CASUALTIES FROM WAR GASES

1. CASUALTY RATES. Casualty rates from the effects of war gases depend on the dose received. This dose, in turn, is represented by the concentration of the agent multiplied by the length of the exposure; it is expressed as Ct, where C is concentration in mg/m^3 and t is time in minutes. Median lethal and median incapacitating doses are shown in Table 3-2. It is evident that a given dose may result from exposure to a high concentration of an agent for a brief interval, or to a moderate concentration of the same agent for a longer interval. The lethal dose is expressed in terms of LCt, and it is sometimes given in terms of the concentration that will cause death after a one-minute exposure, in which event it has the numerical value of one.

2. MODIFYING FACTORS. A number of variables are likely to modify casualty expectations. One of them is the physical condition of the individual. Another is the amount of physical exertion undergone at the time of exposure. Such physical exertion increases the breathing rate and therefore the amount of gas that is taken into the respiratory passages during exposure. Still another variable is the extent to which certain gases that can be absorbed through the skin are actually permitted to come in contact with the skin or remain upon the skin. A further factor is the extent to which the breath has been "held" during a short exposure before masking could be effected.

TABLE 3-2

Median Lethal and Median Incapacitating Dosages for Selected War Gases

Name and symbol	Median lethal dosage ($mg\text{-}min/m^3$)	Median incapacitating dosage ($mg\text{-}min/m^3$)	Eye and skin toxicity	Rate of action
Tabun (GA)	400 for resting men	300 for resting men	Very high	Very rapid
Sarin (GB)	100 for resting men	75 for resting men	Very high	Very rapid
Soman (GD)	GB, GA range	GB, GA range	Very high	Very rapid
Distilled mustard (HD)	600 to 1,000 by inhalation; 10,000 by skin exposure	200 by eye effect; 2,000 by skin effect	Eyes very susceptible; skin less so	Delayed hours to days
Nitrogen mustard (HN-1)	1,500 by inhalation; 20,000 by skin exposure	200 by eye effect; 9,000 by skin effect	Eyes very susceptible; skin less so	Delayed hours to days
Nitrogen mustard (HN-2)	3,000 by inhalation	Less than HN-1, but more than HN-3	More rapidly toxic to eyes than HD, less vesicant	Delayed hours to days
Nitrogen mustard (HN-3)	1,500 by inhalation; 10,000 by skin exposure (estimated)	200 by eye effect; 2,500 by skin effect (estimated)	Eyes very susceptible; skin less so	Serious effects same as for HD; minor symptoms sooner
Mustard (H)	600 to 1,000 by inhalation; 10,000 by skin exposure	200 by eye effect; 2,000 by skin effects	Eyes very susceptible; skin less so	Delayed hours to days
Lewisite	1,200 to 1,500 by inhalation; 100,000 by skin exposure	300 by eye effect; 1,500 by skin effect	Eyes very susceptible; skin less so	Immediate irritation; delayed blistering
Phosgene (CG)	3,200	1,600	None	Immediate to 3 hours
Cyanogen Chloride (CK)	11,000	7,000	Low, irritating to eyes and mucous membrane	Rapid
Hydrogen Cyanide (AC)	Approximately 2,600	Approximately 2,600	Moderate	Very rapid; fatal within a few minutes

PART B. DAMAGE TO PHYSICAL PROPERTY

Section 1. STRUCTURES

3B1.01 STRUCTURAL DAMAGE

1. BLAST EFFECTS. The general effects of blast have been discussed in paragraph 2B1.02. Paragraph E15 of Appendix E defines four classes of damage that is applicable to most structures that are found at naval activities, and Table 3-3 shows a range of overpressures for damage to various types of structures. These ranges are not precise, but they will serve for most planning purposes.

2. DAMAGE TABLES. In Appendix E, Table E-5 shows shatter pressures for various types of glass, including safety glass and wired glass, and for different thicknesses of acrylic plastic.

Figure E-16 represents damage-distance relationship as a function of weapon energy yield for diffraction-type structures and provides a conversion formula for computations when yields are in excess of 20 mt.

Figures E-17 and E-20 are nomograms and bar charts that (a) show damage to be expected at various ranges for drag-sensitive targets and (b) provide a scaling formula for computing results when weapons of other energy yields are employed.

3B1.02 EFFECTS OF FIRES

1. FIRE STORMS. The incidence of fire storms is dependent on the conditions that exist at the time of the attack, including weather, wind, types of structures, building density, and other material in the area.

2. TYPES OF STRUCTURES. Many reasonably blast-resistant buildings have wooden partitions and floors and contain flammable materials. When these materials burn, the result is like that shown in Figure 3-2. The walls may still be intact, but the building is little more than a shell, and its contents are destroyed. When a building of steel-frame construction burns, the steel members may be weakened by heat from the burning of flammable stores, and the building may collapse or be rendered unsafe for further occupancy.

TABLE 3-3

Conditions of Failure for Sensitive Structural Elements

Structural element	Failure	Incident blast overpressure (psi)
Glass panes, large and small	Shattering, occasional frame failure	0.5 to 1.0
Corrugated asbestos siding	Shattering	1.0 to 2.0
Corrugated steel or aluminum paneling	Connection failure followed by buckling	1.0 to 2.0
Brick wall panel, 8 in. or 12 in. thick (unreinforced)	Shearing and flexure failure	7.0 to 8.0
Wood siding panels, standard house construction	Usually, failure occurs at the main connections, allowing a whole panel to blow in	1.0 to 2.0
Concrete or cinder block wall panels, 8 in. or 12 in. thick (unreinforced)	Shattering of the wall	2.0 to 3.0

Figure 3-2. Interior of a Reinforced Concrete Building after a Nuclear Airburst

3. BUILDING DENSITY. Figure 3-3 indicates the probability of firespread as a function of building density. In this figure, building density represents the ratio of roof area to the total ground area, and it is expressed in percentages. Where building density is 0 to 5 percent, fires usually do not spread beyond the buildings in which they originate. Where the building density is 6 to 20 percent, a mass fire usually will not occur unless a number of structures are ignited simultaneously. But where the building density is over 20 percent, the probability of a mass fire is greatly increased when the construction covers an area of a square mile or more. The probability of firespread in relation to existing fire gaps is shown in Figure E-18.

The existence of fire lanes must be an important factor in preventing the spread of fires, but for fires that are described herein, such lanes must be at least 100 ft wide to be genuinely useful. The nature of the terrain may also be significant; streams act as barriers to the spread of fires, and hills serve to intercept direct thermal radiation.

Table E-10 gives some data on the extent to which various types of window coverings reduce the hazard of direct thermal radiation.

3B1.03 CONTAMINATION

Like ground areas, the exteriors and interiors of buildings within target areas are

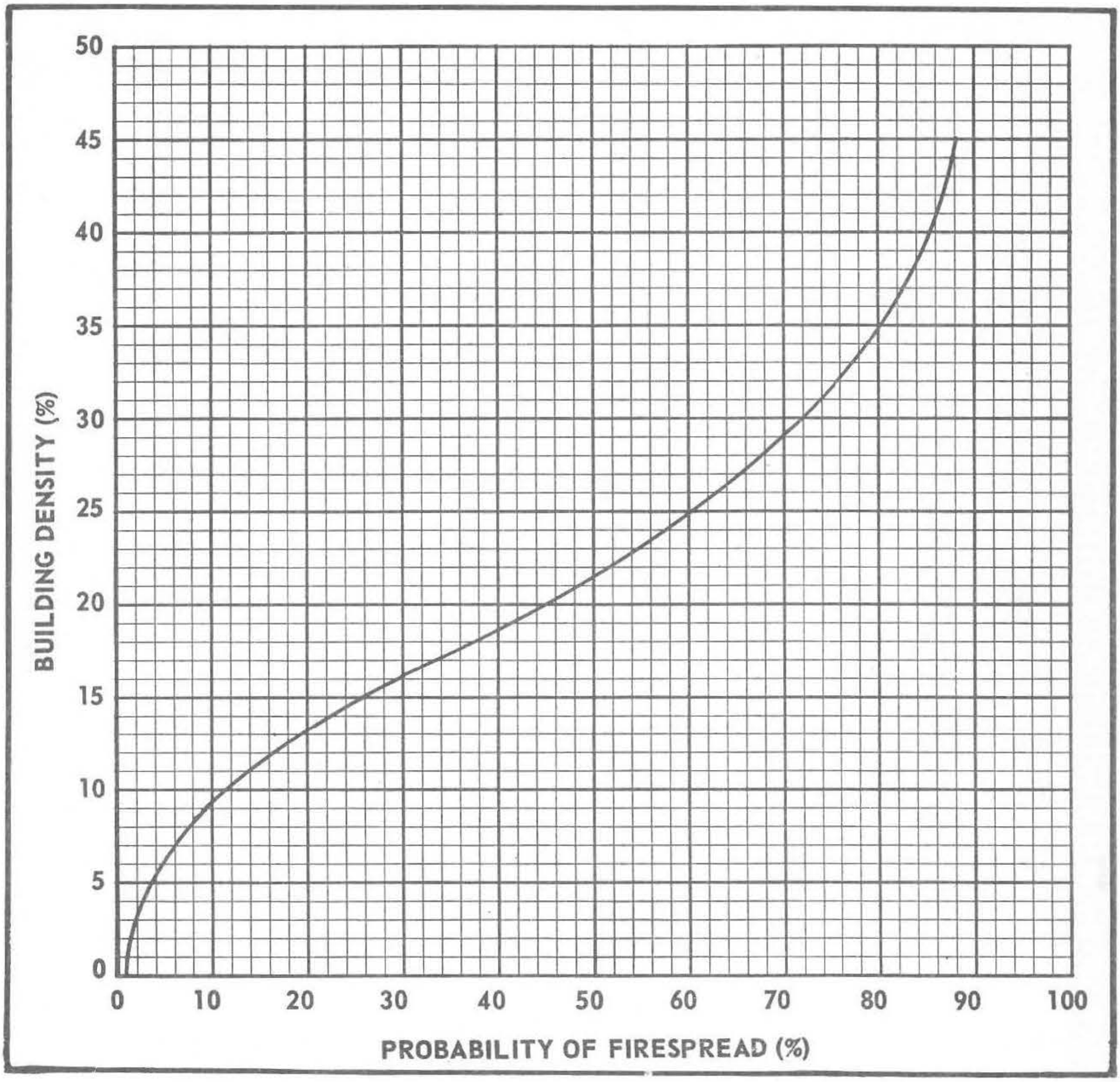


Figure 3-3. Probability of Firespread as a Function of Building Density

subject to ABC contamination that will be a subsequent hazard to personnel. Even though conventional buildings remain largely intact, blast will (a) carry away many windows and doors, and (b) thus provide access for contamination through open or broken doors, windows, and ventilation systems. In the event of a BW or CW attack, interior contamination may present more of a problem to recovery operations than exterior contamination because material weathering will not be as effective and will therefore persist much longer.

3B2.01 EFFECTS OF BLAST ON EQUIPMENT

Various types of equipment are not equally resistant to blast effects. Moreover, special housing of equipment would reduce the anticipated extent of damage. Table 3-4 shows damage criteria for parked aircraft and transmitting towers. In Appendix E, Table E-7 shows damage criteria for land transportation equipment.

3B2.02 FIRE POTENTIAL

Serious fires may develop if stored containers of gasoline and oil are ruptured. Fires in ammunition and ration dumps are a possibility, but a somewhat less likely one.

Secondary fires that develop in damaged buildings necessarily account for the destruction of much equipment, machinery, and supply items.

Critical thermal energies at which materials of supply will ignite are shown in Appendix E, Table E-11.

3B2.03 CONTAMINATION

In the event of nuclear explosions, equipment and material may be beyond the range of blast and thermal damage, but still within the area of the early fallout pattern. Such equipment and material would be undamaged but would be contaminated. As a result, a real hazard to personnel would exist during recovery operations, and decontamination might be necessary before equipment and material could be used again.

TABLE 3-4

Damage Criteria for Parked Aircraft and Transmitting Towers

Parked aircraft		
Damage class[1]	Nature of damage	Overpressure (psi)
A	Complete destruction	6
B	Damage beyond economical repair	4
C	Major shop repair required prior to flight	3
D	Minor or no repair or replacement required prior to flight	1

Transmitting towers	
Damage class[1]	Nature of damage
A and B	Towers demolished or flat on ground
C	Towers partially buckled but held by guylines; ineffective for transmission
D	Guylines somewhat slack but tower able to transmit

[1] The general degrees of damage that are applicable to structures and equipment are:
- A The structure is virtually completely destroyed.
- B The damage is so severe that complete reconstruction is required prior to reuse.
- C The structural damage is such that major repairs are required before the structure can be used for its intended purpose.
- D The structure received light damage so that only minor makeshift repairs (or no repairs at all) are required to maintain its usefulness.

Usually, equipment that is operated in contaminated areas will itself become contaminated. In order that the contamination on the equipment does not add to the exposure level from the ground (thus reducing the permissible stay time of the operators), the equipment should be checked and decontaminated whenever feasible. The relative hazards of BW and CW contamination depend on the persistency and the extent to which personnel are susceptible.

It is possible to provide some protection, through the use of masks and protective clothing, for personnel who use contaminated materials and equipment. The effectiveness of personnel who use this gear, however, will be drastically reduced. The decision on the acceptability of this reduction will govern the requirements for decontamination.

3B3.01 POTENTIAL EFFECTS OF BLAST

1. UTILITIES. Overhead power and communication lines may be expected to suffer damage that is similar to damage caused by severe windstorms. Overpressures in the order of 5 psi will cause severe damage, but in this pressure range the damage to distribution systems can be readily repaired. Sources of extensive damage will be flying missiles, fire, and collapse of structures. At a pressure range of 5 psi, steel transmission towers will not suffer great damage because of their construction.

Underground mains and powerlines are relatively resistant to blast pressures. Usually, no damage would be expected at distances that are greater than 3 crater radii. Damage to water and gas mains may be expected at risers that are inside damaged buildings and where they enter damaged buildings.

2. HIGHWAYS AND BRIDGES. Airbursts are not particularly damaging to highways and streets, but surface and subsurface bursts will destroy them in the vicinity of target center. Steel-girder bridges with reinforced concrete decks are remarkably resistant to airblast damage, although some of the smaller spans may be displaced (Figure 3-4). More extensive damage and displacement would be anticipated in an area that is affected by the ground shock of a subsurface or surface burst. Figure 3-4 shows that the plate girders were moved about three feet by the blast, but the bridge was left essentially intact.

3. DAMAGE-DISTANCE RELATIONSHIPS. Damage-distance relationships as a function of a weapon yield for powerlines, vehicles, and rolling stock are shown in Appendix E, Figure E-17. A scaling formula for use with these data will be found in Figure E-16.

The main problem, especially in areas of high construction density, will be the removal of debris that will block access routes.

Figure 3-4. Structural Damage from a Nominal Airburst to a Steel Plate Girder Railway Bridge Located about 280 Yards from Ground Zero

3B3.02 POTENTIAL EFFECTS OF FIRE

In an area that has been swept by fire, the utilities, services, and transportation routes therein will be completely unusable for a long period. Secondary fires often cause short circuits, which occur when powerlines are broken. Gas from ruptured mains may be ignited and, in turn, may serve to ignite other flammable materials. Secondary fires do additional damage, especially to electrical equipment, and they delay the initiation of recovery measures. Ignition points of various types of electrical equipment are shown in Table E-11. The principal problem that results from fires after an attack will be the strict control of the available water supply.

3B3.03 CONTAMINATION OF STRUCTURES AND AREAS

ABC contamination, especially residual radioactivity, is also a problem with regard to utilities and transportation routes. After fires have burned themselves out or have been extinguished and the work of rehabilitation has begun, various areas may still be completely denied to work parties or may be accessible for only limited periods of time because of the radioactive hazard to personnel.

3B3.04 CONTAMINATION OF WATER

1. POSSIBILITY OF RADIOACTIVITY.

Water in unbroken mains and storage tanks would probably be safe for use after an attack, unless contaminated water has been pumped into the system. Although radioactive contamination of water is not regarded as one of the major hazards that result from nuclear attack, danger to personnel would exist and should be guarded against by post attack monitoring.

2. SEWAGE.

When water mains have been damaged, there is a possibility that damaged sewer mains will cause sewage to seep or flow into the water mains. This will be serious if it occurs in the distribution system beyond the purification station.

Contamination also results from back-siphonage from building fixtures when pressures are reduced by firefighting demands or supply failure. It can occur within buildings when plumbing fixtures are damaged.

3. BW AGENTS.

Biological contamination of water supplies would probably be the result of covert action rather than open attack. It might, however, be timed to precede or accompany open attack.

Covert introduction of BW agents might be effected in (a) reservoirs, wells, or other sources of supply or (b) the distribution system at some point beyond the purification plant. When used to contaminate reservoirs, the agent or agents would have to be types against which normal purification defenses are not completely effective. However, if the agents, together with a chlorine-reducing substance, were introduced into the distribution system beyond the purification point, this requirement would not apply.

4. CW AGENTS.

Water from any questionable source should be tested for chemical contamination, and such tests should be made before chlorination. If the water does not pass the test, an effort should be made to locate an uncontaminated source, because neutralization of certain CW agents is a slow and difficult process. The purification of water that has been contaminated by CW agents is discussed in detail in Appendix C.

3B4.01 EFFECT OF ABC WARFARE ON FOOD

The principal effect of ABC warfare on food will be contamination. In the event of an attack, food contamination will be largely confined to food that is not packed in sealed containers. The exteriors of packaged foods can often be decontaminated and the contents salvaged for consumption. Contaminated food should be tested, decontaminated, and consumed only on the advice of a medical officer.

3B4.02 RADIOLOGICAL CONTAMINATION OF FOOD

The cooking of foods does not remove radioactive contamination, but a certain amount of contamination is considered to be acceptable for limited periods of time, especially under emergency conditions, because (a) ingested fission products are subject to radioactive decay and (b) most ingested fission products are eliminated from the body.

The maximum levels of radioactivity that are permissible in food and water during an emergency are as follows.

Consumption period (day)	Radioactivity level	
	Beta-gamma (dps/cc)	Alpha (dps/cc)
10	3×10^3	180
30	1×10^3	60

In this tabulation dps/cc means disintegrations per second per cubic centimeter. Disintegrations per second are related to a unit that is known as the curie, which is equal to 3.7×10^{10} dps. If both the food and water ingested are equally contaminated, the values shown in the preceding table must be reduced by one half.

When exposed food that is slow to deteriorate is found to be contaminated beyond the acceptable level, it need not necessarily be destroyed, because radioactive decay may solve the problem in time. Foods such as meat may be recovered for use by cutting off the contaminated outer part.

3B4.03 BIOLOGICAL CONTAMINATION OF FOOD

If the use of BW agents is suspected, unpackaged foods should not normally be used because detection techniques that are suitable for quick and accurate determinations are not available. If unpackaged food must be used, the contamination hazard can be reduced by cooking, but the problem would remain for foods that are eaten uncooked.

Covert use of BW agents is possible and includes (a) the introduction of agents into milk or other substances that are ordinarily ingested without having been cooked, (b) the introduction of agents into foods after they have been cooked, and (c) the contamination of serving and mess gear.

3B4.04 CHEMICAL CONTAMINATION OF FOOD

When chemical contamination exists, as evidenced by the positive results of a food testing and screening kit, a decision must be made on whether the food should be destroyed or decontaminated. If the agent is in liquid form or is a member of the G-series, a decision to destroy the food should usually be made. Otherwise, decontamination may be attempted as shown in Table 3-5. Detailed discussion of decontamination procedures for foods is given in paragraph 4E9.05.

TABLE 3-5

Disposition of Chemically Contaminated Foods

Agent	State	Disposition
Phosgene	Vapor Liquid	Aerate for 24 hr or boil Destroy
Chloropicrin	Vapor Liquid	Trim contaminated portion Destroy
Mustards	Vapor Light liquid Heavy liquid	Trim fatty part and aerate remainder Trim; boil in water and baking soda Destroy
Lewisite	Vapor	Aerate and rinse
Ethyldichloroarsine	Light liquid Heavy liquid	Trim and peel; otherwise destroy Destroy
G-series gases	Vapor Liquid	Destroy Destroy
Vomiting gases	Smokes	Trim contaminated portions
Chloroacetophenone	Vapor Liquid	Aerate Trim or destroy
White phosphorus	Smoke Unburned particles	None required Destroy by burning

3B5.01 DEBRIS AND ACCESS

Serious problems are created by debris that impedes mobility and access. Even emergency recovery measures, including rescue and firefighting operations, can not be carried out until roads and streets have been cleared sufficiently to permit access to the affected areas.

Estimates indicate that in an average-sized American city, the depth of debris in a 66-ft-wide street would be as follows:

Distance from ground zero (mile)	Depth of debris (ft)
0.0 to 0.7	4-1/2
0.7 to 1.4	4
1.4 to 2.0	3-1/2
2.0 to 2.7	1-1/2

Concrete roads and streets that are subjected to falling debris will usually sustain less damage than other types of roadways. In the planning of debris removal operations, main arteries that are likely to require little or no repair should be selected for initial clearance. In the clearing of access roadways, care must be exercised not to magnify the damage that was caused by the debris. Debris will usually be a major problem in built-up areas that are subjected to blast pressures in excess of 8 to 10 psi. The relative amount of debris, rather than the level of contamination, may determine the obstruction perimeter after a nuclear attack.

3B5.02 DEBRIS IN STRUCTURES

Interior debris may be sufficiently heavy or concentrated to cause (a) the collapse of floors and (b) the total collapse of the structure itself. Less severe effects of falling debris include damage to the contents of the structures, such as materials in warehouse storage, machinery in shops and generating plants, and vehicles in garages.

The type of damage that is sustained, however, is normally of multiple origin; debris is usually an aggravating factor in a problem that has involved structural collapse and widespread secondary fires. Figure 3-5 shows a situation in which structural collapse, debris, and fire are all factors in the resulting damage.

Figure 3-5. Damage Caused by Structural Collapse, Fire, and Debris

CHAPTER 4. REQUIREMENTS FOR ABC DEFENSE

PART A. WARNING, DETECTION, AND IDENTIFICATION

Section 1. WARNING SYSTEMS

4A1.01 PATTERNS OF INTELLIGENCE

Information on the nature of impending attack can be obtained from many sources. Intelligence may provide warning as a result of (a) studies of strategic patterns, (b) reports of enemy manufacture of specific weapons and agents or concentration of known weapons, (c) information on enemy research on new weapons and agents, or (d) analysis of other data. Such intelligence may relate to nuclear weapons or to RW, BW, and CW agents.

In the area of operations, suspicious or warning circumstances that apply particularly to BW and CW agents may include any of the following:

(1) Smokes or mists that are sprayed from enemy airplanes,

(2) Unusual types of enemy bombs and projectiles, and especially those that contain compressed air or pistons that have been adapted for the dissemination of aerosols,

(3) Parachutes and other devices that might be employed to disseminate ampoules, gelatinous masses, or insect vectors,

(4) Any types of weapons that appear to have little if any immediate effect,

(5) Unusual taste or appearance of food, water, or beverages,

(6) Presence of dead or sick animals in unusual numbers, and

(7) Widespread defoliation of trees or withering and destruction of agricultural crops.

4A1.02 CONTROLLED WARNING DEVICES

When air attacks are directed toward continental areas of the United States, early warning will probably be received from advanced radar lines, such as the DEWLINE. By these means, military installations and civilian defense agencies may receive sufficient advance notice to take shelter and exercise other protective measures. Personnel will be alerted to the impending attack by suitable warning devices (OPNAV INSTRUCTION 3440.8).

4A1.03 WARNING SIGNALS

The particular sound signals to be used by the Navy (Figure 4-1) will depend on the type and limitations of the equipment employed. It is the Navy's policy to establish warning signals that do not conflict with the signals of the Office of Civil and Defense Mobilization (OCDM) There must be a distinction between the "alert" signal and the "take cover" signal. It is well established that a modulated sound is far more easily recognized that a steady sound at the same level. Accordingly, a modulated sound is usually used for the "take cover" signal and a steady sound for the "alert" signal. If a rotating beam of sound is used, the modulation should occur several times per minute, so that a number of repetitions of the modulation will take place while the beam is passing a given point. The most distinctive timing for a series of blasts can be determined by trial. Blasts that last from one to three seconds with approximately equal intervals of silence have been found most effective.

The following types and duration of signals are to be used in connection with an attack warning.

(1) Alert signal: a steady blast that lasts from three to five minutes.

(2) Take-cover signal: a wailing tone or a series of short blasts that last for three minutes.

The alert signal indicates that an attack is anticipated and that recovery teams should mobilize immediately and disperse according to plan (with equipment if time permits). The alert signal will also serve to indicate that nonessential personnel (not assigned to recovery forces or required on station) should evacuate. The take-cover signal indicates

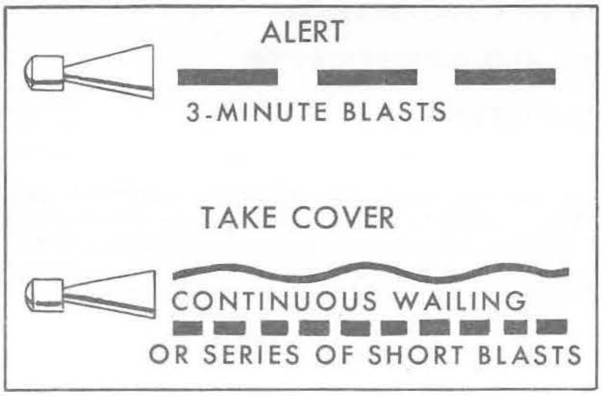


Figure 4-1. Emergency Warning Signals

that attack is imminent and that all personnel should take the best available shelter immediately. The all-clear will not be given by signal but disseminated by other means.

It is incumbent upon the naval activity to make certain that warning signals that pertain to ABC warfare defense are easily identifiable and well known to all hands. Consideration must be given to the possibility of conflict between warning signals and horns that are in regular use in industrial and production areas of shore activities. After all such conflicts have been satisfactorily resolved, a description of the approved warning signal shall be widely disseminated.

Design and installation details of warning systems are considered to be a matter for local decision. However, all signal devices that are used shall have sufficient volume and shall be located so their sound is clearly audible to personnel in all buildings, even when openings are secured. An indoor signaling system may be required when there is a possibility that the exterior system can not be heard because a structure is closed up.

4A2.01 RADIOACTIVE SUBSTANCES

The radioactivity that is considered in this paragraph may be residual, induced, from unfissioned materials, or from combinations of the three. Whatever the source, the presence of radioactivity can not be detected by the human senses.

Radioactivity detection and measurement is of prime importance in the protection of personnel. When the dose rate is known, it is possible to (a) determine permissible stay time for work parties in a contaminated area and (b) establish zones and perimeters for the area as a whole.

As far as areas and inanimate objects are concerned, detection and measurement of radiation are effected through the use of survey meters. Various dosimetry devices, however, are employed to measure accumulated doses of radiation that are received by personnel.

4A2.02 BW AGENTS

No equipment is presently available for field issue to detect and identify BW agents in time for personnel to take protective action, such as by the use of masks.

In fact, it is quite possible that early detection may depend in part upon (a) the recognition that an enemy is using an unusual type of munition or (b) the observation that unusually large numbers of personnel have become ill. In the latter case, identification of the responsible agent would depend upon diagnosis.

When there is any indication that a BW attack has taken place, field sampling and subsequent laboratory examinations and tests can be used to confirm the fact. Equipment and methods that are used in field sampling are discussed in paragraph 4A4.01.

4A2.03 CW AGENTS

Detection of war gases now available can not be based on the presence of unfamiliar odors, but instead must depend on devices, such as (a) specially prepared crayons and papers that are contained in chemical agent detector kits and (b) field alarms when G-agents are employed.

It is imperative that G-agents be detected immediately and that protective measures be put into effect at once. The detection devices can also be employed to (a) test the effectiveness of decontamination measures and (b) determine the hazards of operating in an area that is suspected of being contaminated.

4A2.04 ESTABLISHMENT OF PERIMETERS

After an atomic attack, which may or may not be supplemented by use of BW and CW agents, the first step toward recovery is reconnaissance and survey. As soon as the area has been surveyed, the extent of damage may be known and the obstruction and support perimeters may be established.

These perimeters should be properly identified and marked, and they should be entered on appropriate maps at control centers. Particular attention should be given to areas in which special hazards exist. Obstruction and support perimeters are described in paragraph 5C1.01.

Standard survey markers have been adopted, and details concerning them are shown in paragraph A20 of Appendix A. These markers may be made of wood, plastic, metal, or any other rigid material. Standard size is 11-1/2 in. by 8 in. by 8 in., but these dimensions may be varied to suit materials that are available locally.

Markers are placed with their apexes downward on stakes, fences, trees, rocks, and buildings, and facing away from the contamination so that they may be seen by personnel who are approaching the danger area. On the inward side of a marker is the date of placement and any other data that are deemed pertinent, such as the dose rate one hour after a nuclear explosion.

4A3.01 INSTRUMENTS

Radiological monitoring instruments that are used are of two types: (a) equipment that indicates the intensity of radiation (dose rate) at any given instant, and makes up what is called "survey meters," and (b) dosimeters that indicate the amount of radiation (dose) that is accumulated by an individual.

Different models of survey meters and dosimeters are available for measuring either high (Hi-R) or low (Lo-R) levels of radiation. Radiac equipment in current use is described in paragraphs A8 through A14 of Appendix A and includes the following types: (a) high-range survey meters, (b) low-range survey meters, (c) alpha meters, (d) high-range, nonindicating dosimeters, (e) high-range, self-indicating dosimeters, and (f) low-range, self-indicating dosimeters. All survey instruments are of the direct-reading type. Dosimeters may be either self-indicating or non-self-indicating.

The following general considerations are used in the determination of allowances of radiological monitoring instruments for shore activities.

1. REQUESTS FOR ALLOWANCES. Equipments are provided to outfit passive defense teams that are organized in accordance with the United States Passive Defense Manual, OPNAV INSTRUCTION 3440.6. Information on requirements is usually reported to the Chief, Bureau of Ships, by the commanding officer of the station in the form of a request for the establishment or modification of an allowance. The request is submitted through the chain of command and then via the industrial manager to the commandant of the naval district.

2. BASIS FOR ALLOWANCES. In the absence of a request for the establishment of an allowance, allowances are based primarily on the number of personnel on board at the station. Stations that have a population of less than 100 are not provided with an allowance unless the Bureau of Ships is advised of a radiac equipment requirement. The quantities of equipment that are required to provide for routine maintenance are determined by the Bureau of Ships, and these are added to the actual usage requirements of the activities.

3. EQUIPMENT DISTRIBUTION. Radiac equipment is not to be requisitioned to fill allowances. The equipment is issued by the Bureau of Ships as it becomes available.

Priorities that are established by the Chief of Naval Operations are used to determine distribution when there is insufficient equipment to fill allowances. Equipment is issued without cost to the end-user, and when end-users are shore activities, the equipment is issued without spares.

Maintenance of monitoring equipment is provided free of charge at activities that have been established by the Bureau of Ships. These facilities are listed in Appendix D. Further data on this subject can be obtained from Basic ABC Allowance Planning, Continental Shore Activities and Outlying Bases, NAVDOCKS TP-PL-10 (Confidential), and from the facilities that are listed in Appendix D.

4A3.02 AERIAL MONITORING

After a nuclear attack, one of the first problems will be to determine the level and extent of radiation. Usually, a quick, rough estimate will suffice to provide the command with the data that are necessary to initiate recovery operations. These data may be based on an aerial survey of the area, which will also serve as a guide for subsequent ground monitoring and initial recovery measures.

Gamma rays from fission products on the surface can be detected by sensitive instruments at an altitude of several hundred feet. From such readings dose rates on the surface can be estimated. Figure 4-2 gives correction factors for readings that have been taken at various altitudes. In addition to the use of this correction factor, it is necessary to correct for the structure of the aircraft if the instrument is mounted inside. This correction must be determined for each type of aircraft, and it may be accomplished with a known source of radiation.

Slow-flying aircraft are desirable for aerial surveys, because (a) it is difficult to relate a particular reading that was made in the air to a limited ground area and (b) the instruments do not have immediate response. Flying a planned pattern and coordinating readings with ground locations will increase the probability of accurate coverage, and a general picture of radiological conditions may be obtained. Readings are usually reported to a control center by radio as they are taken in the aircraft. A more accurate determination of radiological conditions may result when helicopters are available for survey duty. With these aircrafts it is possible to hover and to lower instruments and make readings at selected heights.

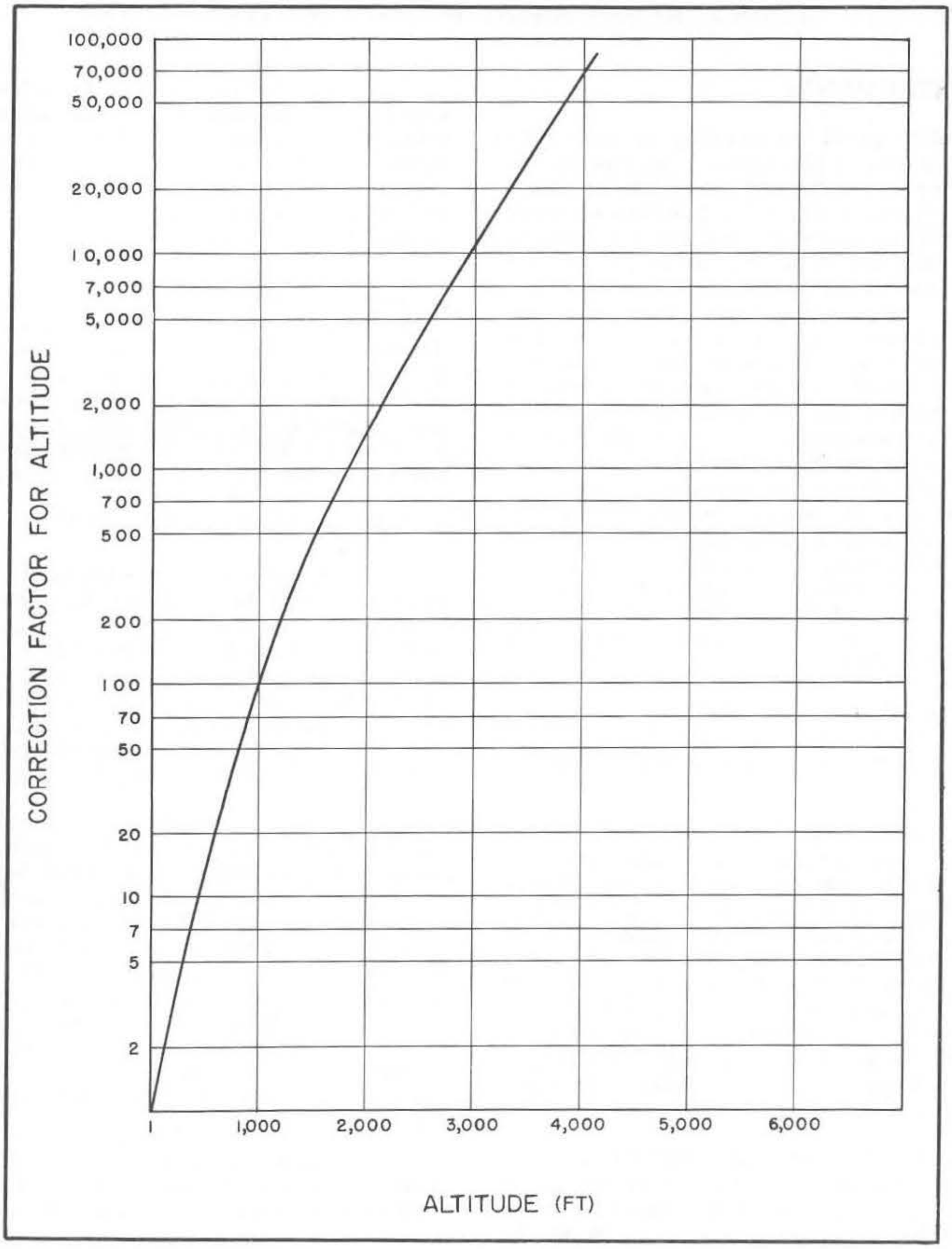


Figure 4-2. Altitude Correction Factors for Radiac Readings

4A3.03 DATA ON FALLOUT

Fallout may be an important aftereffect of a thermo-nuclear attack. The United States Weather Bureau and the Office of Civil Defense Mobilization have established a network of stations throughout the country for the purpose of registering and reporting dose rates. The information so obtained will indicate the progress and extent of fallout. Early predictions that were made by the use of this method (Appendix E) may be verified or modified by the data that are collected by these stations.

4A3.04 GROUND MONITORING

Ground surveys should be delayed as long as possible, consistent with emergency requirements, to permit as much decay of

radiation as possible, so that the exposure of the monitoring personnel will be minimized.

Either of two schemes of surveying may be followed. The first is the predetermined dose-rate method, in which teams start from the boundary of an area and proceed toward ground zero until a predetermined dose rate is encountered. The second is the predetermined point method, in which survey parties proceed to predetermined points and then circle in clockwise direction as they make readings.

ABC survey personnel should wear Hi-R, self-indicating dosimeters. Other parties on emergency missions that relate to rescue, first aid, firefighting, and emergency repair should also have these dosimeters. Such parties should be accompanied by monitors who use high-level survey meters. The readings taken by these monitors should be used to (a) expand the data collected by survey teams and (b) determine the stay times for those parties. The following paragraphs describe certain general procedures to be observed in monitoring.

1. PROCEDURES.

Monitors make readings with instruments that are held at waist height (3 ft) above the ground; such readings are considered to approximate the average dose-rate delivered to a man standing at the spot. Unless otherwise directed, monitors should make readings in open areas that are 30 to 50 ft away from buildings or other large structures. In built-up areas, readings should be made in the center of the street or the center of street intersection. In making open-area measurements, monitors should face all directions while reading their instruments and then report the highest reading. This procedure assures measurement of the maximum intensity in locations where a large part of the radiation is coming from one direction.

When making final readings, monitors should move away from vehicles a distance of at least 20 ft to prevent shielding of the radiation field by the vehicles. For preliminary readings or rapid area-surveys, readings can be made while the monitor is in the vehicle and is holding the instrument outside the cab, but such readings should be so designated in the record.

Monitors should log the location and time of each reading. Location should be in terms of a uniform plotting system that is determined in advance. Possible systems include a grid coordinate system that uses standard maps, street names at intersections, building numbers, and odometer readings of distance from a known point. Notation of time is required by control posts in order to correct readings for decay and thus obtain standard intensities for plotting purposes.

2. CALIBRATION AND CARE OF INSTRUMENTS. To assure reliable measurements, radiacs should be properly calibrated before they are taken into a contaminated area. Upon being removed from the area, they should again be given a calibration check and a zero setting check to determine the reliability of the measurements just taken.

The monitor should protect his instrument at all times. Jarring that is produced by riding over rough terrain or rubble can disturb the calibration. The instrument should never be placed on the floor of a moving vehicle; the safe practice is to carry the instrument on the lap when readings are not being taken. Note also that a radiac should not be permitted to come in contact with contaminated surfaces because of the adverse effect upon its reliability.

3. DATA PROCESSING. Data obtained from monitoring must always be reported back to control center, preferably by radio, as soon as possible. Such data become the basis for the establishment of radiation contours that include the general location of "hot spots" and the determination of the obstruction perimeter.

4A3.05 DETAILED RADIOLOGICAL SURVEY

After the initial ground reconnaissance and survey have been effected, a more detailed survey is conducted to accomplish the following:

(1) Determine the dose rates at specific locations that have special military importance, especially in areas where work parties may be required to operate,

(2) Locate hot spots, which are locations or objects in an area with higher-than-average intensity, and

(3) Establish the location of the radiation contours with greater accuracy.

Radioactive decay proceeds quite rapidly in the hours immediately after a nuclear explosion. If the readings that are taken at different times after the burst are to represent comparable data, they must be reduced to some common denominator by the control center. Accordingly, the common practice is to translate the readings into equivalent rates

for one hour after explosion time. This can be done by using the data in Appendix E, Figure E-14 and paragraph E14.

In the course of the detailed radiological survey, the appropriate markers should be set up as described in paragraph 4A2.04. In marking the areas, give special attention to the location of the danger perimeter, any hot spots that may exist, and the designation of access routes.

As time permits, the detailed survey monitors specific installations, such as food and water supplies, reservoirs, bays, and harbors.

4A3.06 MONITORING AFTER AN ACCIDENT WITH A PLUTONIUM-BEARING WEAPON

The monitoring technique that is required after an accident with a plutonium-bearing weapon varies from the normal techniques that are used for disaster control monitoring. These special techniques and the equipment that is used are discussed in Appendix B.

4A4.01 FIELD SAMPLING

Because no warning device or system of rapid detection of BW agents is available, monitoring will consist of taking samples of materials that are suspected to have BW contamination. The samples must be submitted to a laboratory for analysis. Specially trained personnel and special equipment will be required in making the analysis, which is a medical department responsibility. In an actual situation, it is anticipated that the workload of the medical department will be severe; therefore, the sampling has been assigned as a responsibility of the disaster control organization (ABC Survey Team).

Field samples are of the following types:

(1) Dud munitions, expended munitions, and munitions fragments (dozen samples),

(2) Sampling from air-filtering and concentrating devices,

(3) Swab or wipe samples from contaminated surfaces, and

(4) Food, water, and possibly soil or dust samples.

Laboratory analysis is slow and requires large numbers of trained personnel; therefore, the number of samples that are submitted should be cut to a minimum. Because few BW agents are persistent and the laboratory's studies may take a week or more to complete, the submission of a large number of samples to determine the location and extent of the contaminated area should be discouraged. The passive defense officer should consult with the station medical officer regarding the advisability and extent of effecting decontamination.

4A4.02 FIELD SAMPLING KITS

Biological warfare field sampling kits are in limited supply, but have not performed adequately under field use, and are available only at training activities. They may be improvised. One kit is shown in Appendix A, Figure A-19. Complete instructions for the operation of the M17 field sampling kit are included in the case. All field sampling kits must contain the following.

(1) Containers to (a) protect samples from further contamination and (b) facilitate handling (for example, plastic bags, sterile cap jars, and bottles),

(2) Sterile cotton swabs, small vials of sterile water, and isotonic salt solution or "nutrient solution",

(3) A device to trap and concentrate airborne BW agents. Air sampling is usually accomplished by drawing air at a rate of approximately 0.5 to 1 cu ft per minute (5 to 10 liters per minute) through water or other solution. Many of the airborne BW agents are retained in the liquid, and this liquid becomes the sample. For air sampling in buildings a somewhat lower sampling rate may prove feasible because BW agents tend to remain in interiors for perhaps 10 to 15 minutes after the primary cloud has passed.

4A4.03 AIR SAMPLING TECHNIQUES

The BW sampling kit contains a hand-driven vacuum pump to draw the air through a utensil that contains a special fluid. The operator must be masked. The fluid, together with the entrapped bacteria, is the sample, and it is further processed in the field by filtration through a membrane filter. The filters are placed in a special plastic container with some nutrient fluid (bacterial food); the container is slipped into a vest worn by a courier. This enables partial growth of the bacteria enroute to the laboratory. The filtrate (filtered fluid) must also be transmitted (because agents that are smaller than bacteria (rickettsiae and viruses) may slip through the membrane filters. The procedure is described in detail in the instructions that are contained in the kit.

1. EXTERIOR AIR SAMPLING. Because BW clouds are invisible and last only a few minutes, great practical difficulties arise. The enemy must be caught in the act. BW air sampling should be conducted when the activity is:

(1) Directed to do so by competent authority,

(2) Under attack by an aircraft that is conducting obvious spray operations, and

(3) Attacked with unusual munitions. Air-dropped munitions are usually small and designed to give maximum dispersal. They may be miniature spray devices or contain small explosive charges. Sampling should continue for 10 minutes, and the exact time and location should be indicated on the sample jar.

2. INTERIOR AIR SAMPLING. BW agents may remain suspended in the air in protected buildings for 15 to 30 minutes after the primary (exterior) cloud has passed. If a suspicion exists that a BW attack is underway or has taken place, interior air samples should be taken as soon as apparatus is available (after exterior air sampling is completed).

4A4.04 WATER SAMPLING

When water samples are taken, the pathogens are already in a fluid medium. Samples are taken from the suspected source, placed in a filtration unit, and filtered through membrane filters that are a part of the M17 BW sampling kit. Bacteria are trapped on the membrane filters, and the filters are then dealt with as in the case of air samples. Refrigerated filtrates should be obtained if the presence of viruses or rickettsiae is suspected.

Raw water sources, such as lakes, should be sampled as close as possible to the intake of the water treatment plant and at surface level. Three samples of approximately 1,000 cu cm should be obtained. When the raw water source is a stream, similar samples should be taken at locations that are 100 and 1,000 ft upstream from the intake.

Treated water in storage tanks and reservoirs should be sampled at the surface and from the discharge pipe. One set of samples (1,000 cu cm each) is ordinarily sufficient unless the source is unusually large.

Water in a distribution system is checked for BW contamination by taking 1,000 cu-cm samples from the mains, rather than the laterals. Samples should be taken at hydrants or directly connected service locations and at one-half mile intervals, or they should be taken at key locations. If all samples are taken simultaneously, the results may indicate the location of the contaminating source.

4A4.05 SURFACE SAMPLING

Until continuous operating air samplers or BW alarms have been perfected, a likelihood of obtaining a sample of the primary cloud appears small. Probably the next best source of samples is contaminated surfaces. To take a sample, a moistened cotton swab is wiped or rolled over about nine square inches of surface. The swab should be placed in a sterile bottle that contains a little sterile diluting fluid to keep it moist, and it is then shipped to the laboratory.

Samples should preferable be taken from smooth surfaces, such as glass, smooth metal, painted wood, and smooth concrete or asphalt. When samples are taken outdoors, the sampling surfaces should be in exposed places, and if the path of a pathogenic cloud is known, the samples should be taken at 100-ft intervals in the mid-path of the cloud. In such instances, samples are normally taken from vertical surfaces at a height of four to six feet. If the path of a BW cloud is not known, it may be advisable to sample horizontal surfaces also, especially if some time has elapsed since the attack. Care should be taken to avoid surfaces that are protected against deposit of germs from the aerosol or subjected to direct sunlight or unusual temperatures. Locations at which exterior samples are taken must be entered on a map, which is sent to the laboratory and used to determine appropriate samples for processing. Later, this map becomes the basis for plotting the contaminated area.

4A4.06 SOURCES OF SAMPLES

The best location from which to take samples is near the point of release of bombs and other munitions that are suspected to have contained BW agents, because obviously the concentration of those agents would be greatest at and about the point of release. If the suspected agent has been delivered by airplane spray, surfaces that are known to have been in the path of the BW cloud are appropriate sources of samples. When the direction of a cloud path is unknown, one of two sampling patterns may be used: (a) four complete sets of 12 samples each are taken because four possible wind directions are assumed; (b) samples are taken in locations where the direction of the BW cloud path would have little or no effect. The latter is considered to be the preferred method.

1. EXTERIOR SAMPLES. When a sample is taken to determine the extent of exterior contamination, a definite sampling pattern is highly desirable because it minimizes the amount of laboratory work that is required in processing the samples. One suitable pattern that consists of a series of concentric circles is shown in Figure 4-3. Samples should be taken at 400-ft intervals along the circumference of each circle.

2. INTERIOR SAMPLES. Interior samples should represent both vertical and horizontal surfaces on every floor of the structure. The surfaces should include some that have not been cleaned since the suspected BW attack. One sample should be taken for every 1,000 to 1,500 sq ft of floor space. An exception may be made when a building has an operating mechanical ventilation system; then samples from surfaces around the intake and exhaust vents may indicate the extent of contamination in the building.

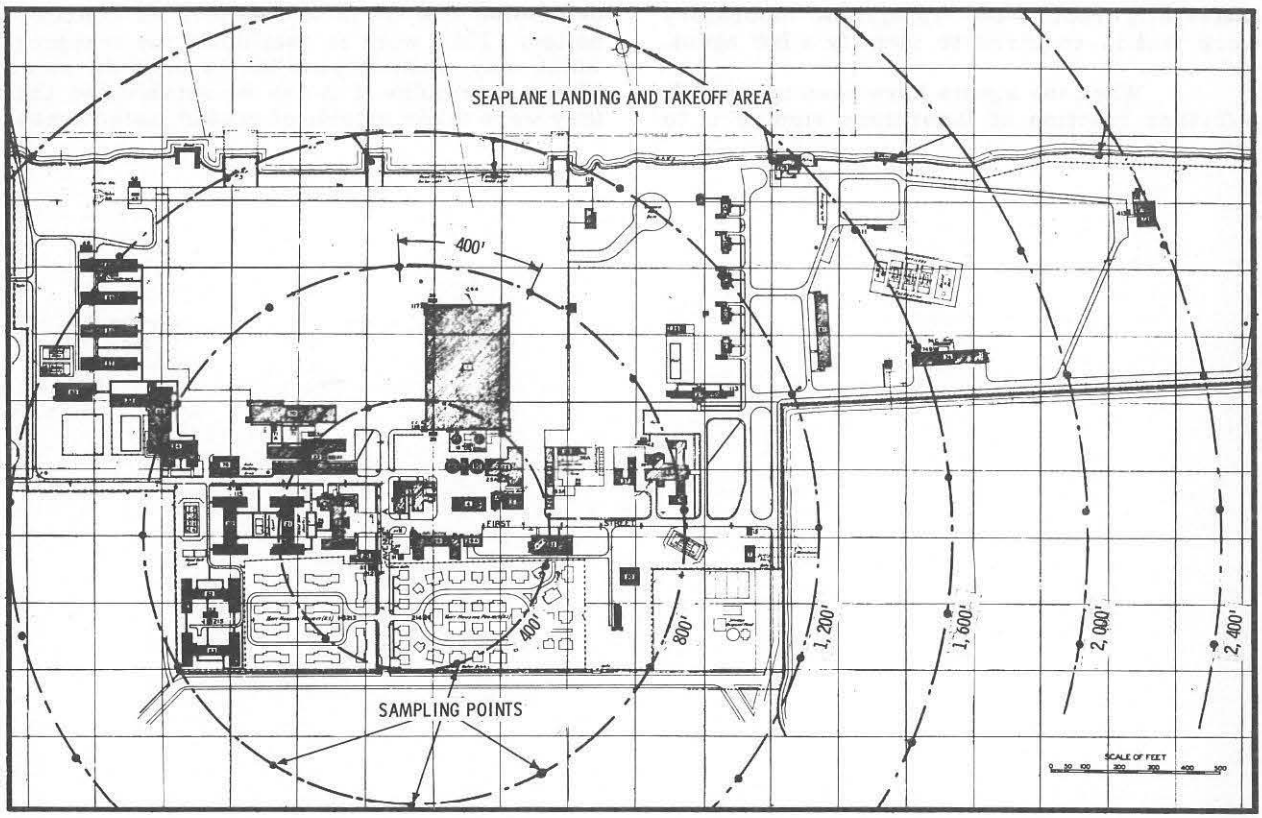


Figure 4-3. Pattern for BW Exterior Surface Sampling

4A4.07 SOLID SAMPLES

Solid samples are objects of convenient size that are suspected to have received BW contamination. They may include debris from bomb craters, enemy ammunition components and spray gear, small, dead animals the size of rats, and any other unusual objects. These samples are used primarily to identify BW agents. Armed and unexploded munitions must be disarmed before they are sent to the laboratory. If dead animals have to be shipped any appreciable distance, they should be frozen in dry ice or "snow" from carbon dioxide fire extinguishers. The field sampling kits contain plastic bags for the collection of solid samples.

In this type of sampling, the field work is limited to the collection of materials, swab samples from the surfaces of suspected objects, and forwarding the materials and samples to the laboratory.

4A4.08 SHIPMENT OF SAMPLES

Unfortunately, a uniform technique for the shipment of samples that have sustained BW contamination can not be recommended because different types of agents vary in their requirements. It is anticipated that the Bureau of Medicine and Surgery will issue instructions on this point. After collection, samples should be taken to a medical officer for recommendations regarding the packaging of the shipment. Speed is essential. The Bureau of Medicine and Surgery has already procured special shipping containers that will facilitate the shipment of biological samples.

4A4.09 LABORATORY STUDIES

Because a BW agent may be of a little known type and difficult to identify, laboratories must be well equipped and staffed with highly trained personnel.

It is the responsibility of the laboratory to receive samples and culture any pathogens that are obtained. The pathogens are then subjected to biochemical and biological tests. In some instances, a presumptive diagnosis or identification can be made in 24 hours. In others, the time that is required for identification may range from two to five days. Careful field sampling by trained teams can

materially reduce the amount of laboratory work that is required to identify a BW agent.

When the agents have been identified, a further function of laboratory studies is to determine the extent and pattern of contamination. This work is facilitated by mapping, which may make it possible to omit the study of some samples if it can be established that they were taken outside of contaminated areas.

4A5.01 FIELD DETECTION

In the event of a CW attack, rapid detection is imperative so that protective measures can be taken. The newer gases and other new agents act so rapidly, even in minute quantities that the only solution is for all personnel to don masks at the first suspicion of a CW attack. After this has been done, available detection devices may be used to (a) determine whether a CW agent has actually been used and (b) identify the agent. There is no universal detector for all agents and for use under all conditions. There is a means of detecting and identifying each of the agents that are known to be available to a potential enemy. All of the available detection devices do give an immediate reading, and unlike BW detection it is not necessary to send samples to the laboratory.

In addition to the initial detection and identification, other detection operations will be required. The most important of these surveys are made on:

(1) Areas and buildings to determine extent and degree of contamination,

(2) Areas to determine when it is safe for personnel to remove masks,

(3) Areas and equipment to determine effectiveness of decontamination,

(4) Water to determine hazard and necessary treatment, and

(5) Food supplies to determine hazard.

4A5.02 FIELD SAMPLING DEVICES

Several devices are available for the detection of CW agents, and each is designed to serve a definite operational requirement. All present devices are dependent upon a chemical reaction between the gas and the indicating material, and the presence of gas is manifested by a color change in the material. For example, an automatic alarm that operates on this color change principle is used to detect G-agents. A photocell detects changes in color on a paper tape and activates an audible warning. This alarm operates continuously on an intermittent cycle and may be set up to sound an alarm even at a remote location. Books of specially treated paper that can be exposed around an area prior to an attack are also available. The paper can be inspected after an attack, and a general idea of the extent and amount of agent that is used can be quickly estimated. All available CW detection devices and their most suitable applications are discussed in the following paragraphs and in paragraphs A3 and A4 of Appendix A.

4A5.03 AIR SAMPLING DEVICES

Because almost all CW agents are in a gaseous form, the usual method of detection is by air sampling. There are three devices for this purpose.

1. AUTOMATIC FIELD ALARM. The automatic field alarm, which is used to detect dangerous quantities of nerve gases, is explained in detail in paragraph A1 of Appendix A. In general, these units should be

(1) Distributed to monitor the entire essential area of a station, with priority being given to the most densely populated sections.

(2) Largely located upwind from the area to be protected, if a prevailing wind direction exists.

(3) Located approximately 5 ft above the ground. However, if an individual building with power ventilation, such as a hospital, is to be protected, the alarm should be installed at the vent intake.

(4) Located in open areas away from forests or other natural shelters and at least 6 ft from single-story buildings, 10 ft from two-story buildings, and 5 additional ft for each story above the second story.

(5) Conveniently located for daily inspection, servicing, and maintenance.

These alarms can be installed to sound a local alarm, give a warning in a central control room, or stop mechanical blowers or a combination of blowers.

2. CHEMICAL AGENT DETECTOR KITS M18 and M15. The other air-sampling devices are the chemical agent detector kits that are described in detail in paragraphs A3 and A4 of Appendix A. The principle of operation and use of these kits is to draw air through small detector tubes with a small hand pump. The number of strokes that are required to get a color change in the detector tubes indicates the concentration of gas present. Each gas requires a different tube and treatment. It is therefore possible to identify as well as detect. Initially, it may be necessary to test with each

type of detector tube. When the agent has been identified, only tubes for that agent need be used thereafter. Two kits are supplied--the M18 contains tubes for all known war gases and the M15, a so-called simplified kit, contains only those tests for the most likely agents that are expected to be used, namely mustard (H), distilled mustard (HD), nerve gases (G), and cyanogen chloride (CK) (Figure 4-4).

4A5.04 SURFACE SAMPLING

For surface sampling, a chemical agent detector kit can be used in the atmosphere directly above suspected surfaces in the same manner that is employed for air sampling.

Another method of surface sampling is through the use of vesicant detector crayons. These crayons are sensitive to most mustards and are used for sampling on surfaces that are suspected to have sustained liquid contamination. The crayons can be used like an ordinary crayon to mark the suspected surface, or shavings from them can be spread on suspicious droplets of liquid. Details of these crayons are contained in paragraph A2 of Appendix A.

Vesicant detector paper, which is sensitive to most mustards and G-agents in liquid form, can also be used for area surface surveying. Prior to attack, sheets of this paper are mounted throughout the area of interest (50-ft intervals is usually considered adequate), so that simple examination will indicate the extent of contamination on open surfaces. This paper can also be used like a blotter on surfaces that are suspected to be

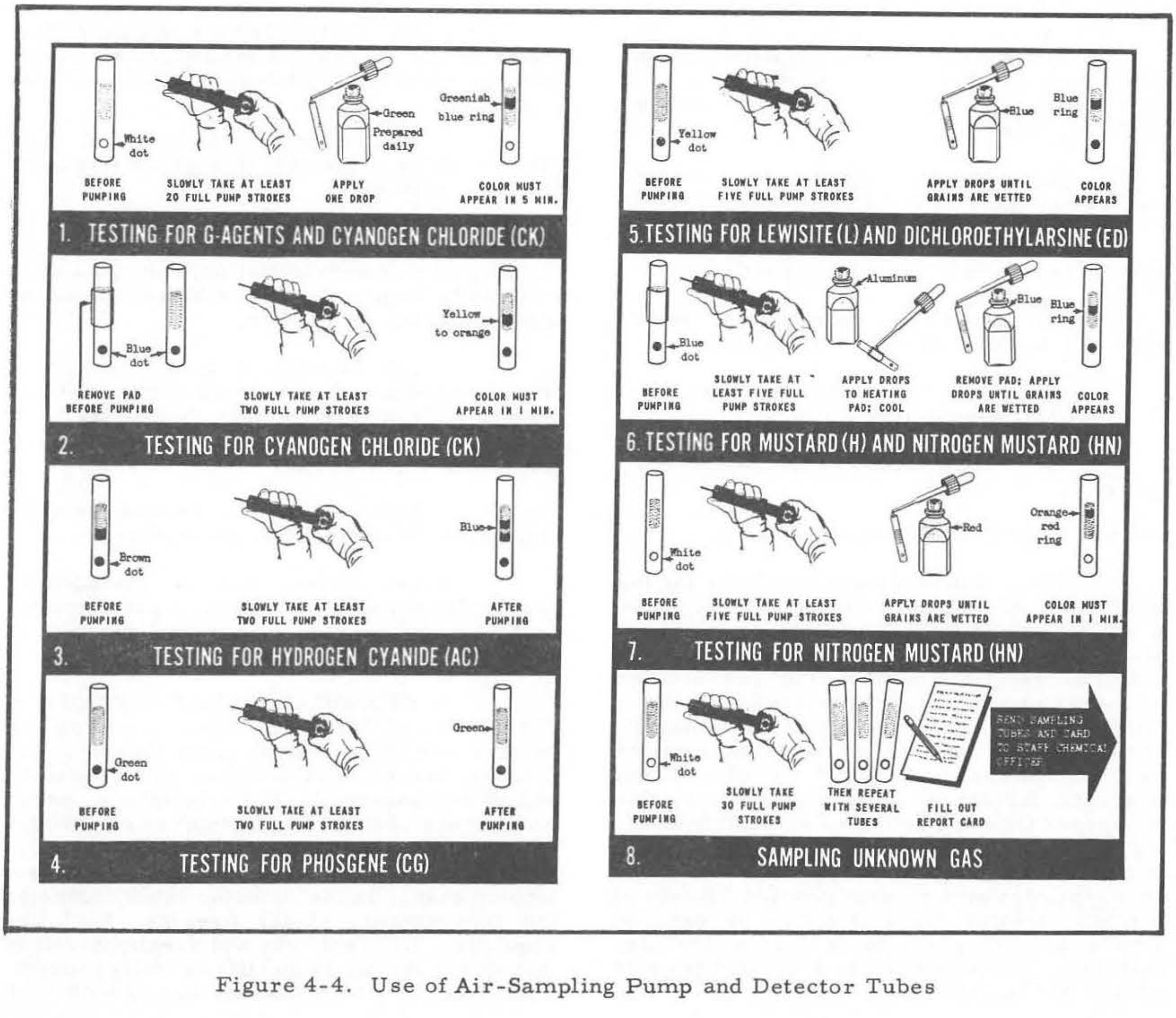


Figure 4-4. Use of Air-Sampling Pump and Detector Tubes

contaminated. Additional details are contained in paragraph A7 of Appendix A.

4A5.05 WATER TESTING AND SCREENING

The relative solubility and decomposition of CW agents in water varies. Phosgene (CG) and diphosgene (GP) decompose rapidly to form nontoxic products. Mustard (HD) is slightly soluble in water, although when it is in solution, it hydrolyzes readily to form nontoxic products.

Lewisite (L) hydrolyzes almost at once to form the toxic lewisite oxide. The nitrogen mustards (HN series) eventually hydrolyze to form nontoxic products, but this process may take six or more days. Cyanogen chloride (CK) also forms harmless products after hydrolysis, but the process of hydrolysis is slow. Soman (GD) and sarin (GB) ultimately hydrolyze, but their decomposition products are toxic and drinking water so contaminated may be hazardous. Tabun (GA) is hydrolyzed by water to form a toxic cyanide compound. Hydrogen cyanide (HCN) is highly soluble in water and undergoes little change with the passage of time.

Contamination of water supplies is to be expected in areas that have been subjected to CW attack. The contamination may be relatively persistent, and unless proper safeguards are observed, it can produce many casualties. Mere observation is not a reliable indication of contamination, but it can convey certain warnings. The presence of wilted vegetation along the water's edge, dead fish in the water, or discoloration may be regarded as warning signs. Suspicion should always be confirmed by chemical tests.

The M2 water testing and screening kit (paragraph A23 and Figure A-23 of Appendix A) has been developed for field detection of dangerous contamination in untreated water, but it can not be used to test chlorinated water. The kit is designed to screen out sources of untreated water that are so contaminated that they can not be rendered potable by customary field methods. If water is tested and found to be free of chemical contamination, it may be used after chlorination or iodination that will render it safe from bacterial contamination. When tests are carefully performed, the threat of serious casualties that result from the presence of known agents is avoided.

When chemical tests indicate that a water source is contaminated, safeguards must be extablished to prevent personnel from drinking the water. An alternative source of uncontaminated water should be sought immediately. Decontamination is a tedious procedure, and an uncontaminated source should be found if at all possible.

When it is necessary to use contaminated water, the M4 water testing kit (paragraph A24 and Figure A-24 of Appendix A) must be employed to determine the specific characteristics and degree of contamination, so that appropriate treatment equipment and techniques can be used (Appendix C). In the hands of trained personnel, the water testing kit will serve to (a) identify the CW agent and (b) carry out quantitative determinations that will indicate the amounts of chemicals that are necessary for adequate water treatment.

To detect covert attacks that employ chemical agents, some continuous monitoring is desirable. A possible technique for this purpose is the use of fish (Appendix F), because they are more sensitive to many chemical constituents than are humans.

4A5.06 FOOD TESTING AND SCREENING KIT, CHEMICAL AGENTS, M2

Modern methods of packaging and stowing foods minimize the danger of contamination by CW agents. The possibility of contamination, however, does exist, especially for nonpackaged foods. It is a responsibility of the medical department to pass on the suitability of both foods and water; other personnel, however, may be called upon to assist in either or both processes.

The M2 food testing and screening kit is shown in Figure A-5 and described in paragraph A6 of Appendix A. The kit is designed to detect dangerous concentrations of the nerve gases (G-series) mustard (H), nitrogen mustards (HN-series), arsenical blister gases (L and PD), and the arsenical smokes (DA and DM) on foods and food packages.

Any food supplies that have been subjected to CW attack should be used only after careful tests have been made by competent personnel.

The susceptibility of foods to contamination by CW agents depends upon the agent involved, the degree of exposure to the agent, and the nature of the food substance itself. Fats, for example, absorb blister gases and nerve gases readily, and if these agents become diffused through foods of high fat content, it may be impossible to remove them. Acid-forming gases may hydrolyze in foods of high water content to produce end-products that are unpalatable. In general, the foods of low fat and water content are not easily contaminated by known CW agents.

PART B. INDIVIDUAL PROTECTION

Section 1. PROTECTIVE CLOTHING AND ACCESSORIES

4B1.01 CONCEPT OF PROTECTION

1. GENERAL APPLICATION. In addition to personnel shelters, individual protective items are required for persons who will be unable to remain in shelters. The whole concept of individual protection is to keep contaminants off the skin and prevent their inhalation or ingestion by the individual. It is necessary, however, to stock special treatment kits for use against contamination by some of the agents in order to prevent damage to the skin, eyes, and nervous system when protection fails. The effects and reactions of the many possible ABC warfare agents vary widely, and therefore no universal individual protective system is 100-percent efficient against all. The aim in the development and selection of protective equipment has been to make each item apply as universally as possible. This aim has been reached insofar as the protective mask is concerned. It provides excellent protection against the inhalation of all airborne BW and CW agents as well as radiological particles. Lacking masks, individuals may improvise to secure some protection with his own handkerchief or similar material against air-spread radioactivity or sprayed biological germs. It should be noted that this will provide no protection against CW agents. Their use in such emergencies could reduce casualties from surprise attacks where modern protective masks are not immediately available. For example tests have shown that:

a. Eight layers of a man's cotton handkerchief is approximately 88.9 percent efficient, while 16 layers is approximately 94.2 percent efficient.

b. A turkish towel folded once is approximately 85.1 percent efficient as a filter.

c. Three layers of ordinary toilet tissue is approximately 91.4 percent efficient. However, it cannot be used very long because it tears after dampening from breath's moisture.

2. SPECIAL PROTECTION. The defensive concept for most personnel will be to get out of the contaminated area as quickly as possible or into protective shelters. For this concept, ordinary clothing, protective masks, and certain self-aid devices will usually be adequate. Conversely, members of disaster control teams who are required to work in contaminated areas will need more protection than most personnel and a different type of clothing. A possibility exists that some decontamination personnel may have to work in highly contaminated areas such as in a building near which a CW bomb has exploded. It should be emphasized that no available equipment is adequate as a protection against high-intensity initial radiation or nuclear fallout. The following paragraphs and Appendix A describe each of the available protective items and indicate the situations in which they are applicable.

4B1.02 ORDINARY CLOTHING

Masks that are used with ordinary work clothing, such as underwear, field socks, coveralls, field boots, and watch caps, are considered to be very limited protection in any contaminated area. Such a combination provides almost complete protection against BW agents and limited protection against CW agents. Under most conditions, personnel who are wearing this outfit should either leave the contaminated area or seek appropriate shelter. Protection that is afforded by ordinary clothing against blister agents can be improved if the clothing is impregnated through the use of the field impregnating set that is described in paragraph 4B1.12.

4B1.03 FOUL WEATHER CLOTHING

Foul weather gear of standard stock issue will protect ordinary clothing and the skin from direct contact with liquid contaminants and radioactive particles. Although vapors and aerosols will penetrate through the closures, the amount of vapor that will penetrate to the skin will be reduced. To minimize this effect, masking tape or adhesive tape should be used to seal all closures and vents snugly. A complete outfit, including a parka, trousers, rubber boots, and gloves, provides an excellent means of preventing radioactive materials from getting on the skin and clothing of members of decontamination teams who are working in a radiological fallout field. For this reason, these outfits should be worn by all

members of disaster control teams in such areas. Foul weather gear does not provide adequate protection against CW agents for recovery personnel nor does it provide protection from gamma radiation.

4B1.04 PERMEABLE PROTECTIVE CLOTHING

Permeable protective clothing is special clothing that has been impregnated with chemicals that neutralize the vapor and fine spray of blister agents. Clothing of this type can be impregnated (a) at plants that are operated by the Bureau of Supplies and Accounts or (b) in the field through the use of an M3 clothing impregnating set (paragraph 4B1.12). Because the garments are permeable, air will pass through the fabrics, and the clothing is more comfortable to wear then impermeable clothing. Members of disaster control teams usually wear permeable clothing when the teams are operating in areas that have been contaminated with CW agents. Such clothing is also adequate protection against any known BW agent. The fabric, however, does not protect personnel against large drops or splashes of blister agents and affords no more protection than normal clothing against G-agents. When large drops of a blister agent are present, the wearer should immediately cut out and discard contaminated portions of the fabric and change to clean clothing as soon as possible.

4B1.05 IMPERMEABLE PROTECTIVE CLOTHING

Impermeable protective clothing is made of cloth that has been coated on both sides with butyl rubber. This clothing does not permit the passage of air through its fabric, and hence it may be worn comfortably for only a limited time. Impermeable clothing, however, does provide the most complete protection that is currently available against BW and CW agents. As a rule, it will be required only in areas that have received heavy liquid contamination. Although resistant to liquid CW agents, impermeable protective clothing will be penetrated after a few hours of exposure to heavy concentrations. Therefore, liquid contamination on the clothing should be neutralized or removed as quickly as possible.

4B1.06 PROTECTIVE MASKS

A protective mask will protect the wearer against the toxic effects of ABC warfare agents. However, in enclosed spaces that contain very high concentrations of a CW agent, the life of the canister will be extremely short. The mask is not intended for use where (a) an insufficient supply of oxygen is in the air or (b) for protection against toxic effects of carbon monoxide, ammonia, or acid and organic vapors that are encountered in the handling or manufacture of chemicals. Therefore, under these conditions, the oxygen-supply type of mask, such as an oxygen breathing apparatus (OBA), is recommended.

1. AVAILABLE MODELS. Two models of protective mask are currently available for use in the Shore Establishment. The ashore masks are the Army M3A1 lightweight service mask (LWS) and the M9A1 protective field mask. The Army M3A1 mask, because of its age, is currently being dropped from the system. Both the LWS and the M9A1 masks are issued complete with carrier, face piece, canister, protective ointment kit (paragraph 4B2.02), and an antidim material that will prevent fogging in the eyepieces. Masks are required for all personnel who must operate in contaminated areas or who might be caught in such areas during or following an attack. These masks are also required for personnel who occupy nonpressurized shelters. The effective life of a mask is dependent upon the life of the canister, which varies with the type and concentration of agent in the air, the time of exposure to the concentration, and the rate of breathing of the wearer. The military canister rarely breaks down suddenly. Usually, it fails gradually, and the wearer is warned of the need for replacement by sensory effects, such as a slight but persistent odor of gas or an irritation that is caused by gas vapors. These effects, however, may be due to a poorly fitted mask, which is a more common cause than an exhausted canister.

2. HOODS AND EYE GLASSES. Because of the variations of the size and shape of individual faces, some leakage around the edges of a mask facepiece may be expected. For protection against some CW agents, this leakage is not serious, but for BW and some new CW agents it may well be critical. Therefore, an additional hood is required to protect personnel, such as disaster control teams who are exposed for long periods. These hoods are discussed in more detail in paragraph 4B1.07 and also in paragraph A28 of Appendix A.

Protective eye glasses are available by prescription from the medical officer for personnel who must wear glasses with a mask. The eye glasses are designed to fit as inserts inside the eye pieces of the mask. Repair kits for local repair and maintenance of masks of both types are furnished. These kits are described in detail in paragraph A36 of Appendix A.

4B1.07 HOODS

Hoods are essentially an impermeable cover for the protective mask and are made of butyl rubber-coated cloth; they are designed for semipermanent mounting on both the M3A1 and M9A1 masks. Hoods are required by members of disaster control teams who must work for long periods of time in areas that are contaminated with BW or CW agents. The hoods are designed so that exhaled air will maintain a positive pressure inside, thus preventing agents from entering. The main purpose of the hoods is to prevent contaminated particles from lodging on the periphery of the mask and the otherwise exposed areas of the neck and face.

4B1.08 WEARABILITY

Personnel who are required to work while they are wearing protective gear, even just masks, must be given periodic rest periods so they can maintain work efficiency and to drink, eat, and smoke. The length of time personnel may be expected to remain in complete protective gear will depend upon the temperature and physical exertion that is required. Under average conditions, personnel can reasonably be expected to remain protected for several hours in all except the impermeable outfit. The following tabulation can be used as a guide in the determination of the wearability of the impermeable protective suit.

Temperature (°F)	Wearing time (hr)
above 90	1/4
85-90	1/2
70-80	1-1/2
60-70	2
50-60	3
30-50	5
below 30	8

4B1.09 PRECAUTIONS

a. Personnel should take the following precautions in putting on protective clothing.

(1) Trouser legs should be tucked inside boot tops; if field shoes are worn, the legs should be tucked inside the socks. Any excess should be arranged to blouse over the tops of socks or boots.

(2) All buttons and other closures should be fastened securely.

(3) All flaps should be interleaved securely.

(4) Neck closures and cuffs should be securely fastened, and gloves should be drawn over the sleeve cuffs.

b. In taking off protective clothing particular care should be taken so that contaminated portions will not come in contact with the skin.

4B1.10 STORAGE OF PROTECTIVE CLOTHING

Certain precautions should be taken to prolong the life of impregnite in permeable protective clothing that is placed in storage. These safeguards are as follows.

(1) The garments should be stored in a cool, dry, well-ventilated place that is protected from direct sunlight.

(2) The garments should not come in contact with organic solvents, such as alcohol, gasoline, dry-cleaning solvents, tetrachloroethane, or similar compounds. Even vapors from these substances are detrimental.

(3) Damp clothing should be dried in a cool, shady spot as soon as possible.

(4) Mothproofing agents should not be used on impregnated clothing.

(5) Deteriorated garments should not be placed in contact with serviceable garments. Garments that have lost their impregnite content cause and accelerate deterioration in serviceable clothing.

Before and after use, impermeable protective clothing can be stored uncovered for long periods without apparent deterioration. Normal storage procedures are also applicable to foul weather gear and ordinary clothing.

4B1.11 CLOTHING TESTS AND TESTING KITS

No reliable test kit is available to the field for use in the determination of the protective qualities of impregnated clothing. The M1 impregnite-in-clothing test kit has proven unreliable in service use and has been withdrawn from the supply system. To assure protection of personnel, all clothing should be impregnated after every laundering or every time it has been worn for one week.

When impregnated clothing is expected to remain in storage for longer than three months, a swatch of the clothing material should be attached to the garment prior to impregnation. These swatches should be stapled

to the bottom hem of a parka and inside the waistband of trousers. The new E14 impregnite analyzing kit, which destroys the cloth being tested, can be used to test the swatches and thus determine the suitability of impregnation after a garment has been in storage. This kit is expected to be in the supply system in the near future. Swatches should remain attached to the clothing until it is worn. A visual inspection of each garment should be made to discover defects such as rips, tears, and worn places that might permit passage of war gases. Meanwhile, the clothing should be tested for strength. This can be done by taking a single layer of cloth in both hands and giving it a quick jerk; if the cloth gives way, it has rotted and must be discarded. Another method is to try to force the thumb or the blunt end of a pencil through the cloth; if this can be done easily, the clothing must be discarded. If the first sample quantity does not pass the test, the minimum sample quantity should be doubled (Table 4-1).

4B1.12 CLOTHING IMPREGNATING SETS

In emergency situations, it may be desirable to impregnate ordinary clothing. The M1 clothing impregnating set will impregnate 30 two-layer suits and the M 3 (Figure 4-5) will impregnate 20 two-layer suits of clothing. No accessories are needed with the M 1 set; however, to use the M 3 set, the following accessories are required: (a) a 24-gal-minimum container, (b) a container to measure water, (c) a stirring paddle, (d) a clothesline. Fresh water should be used with both sets; salt water, however, may be used in emergencies.

Figure 4-5. Impregnating Set, Clothing, Field, M3

A minimum of three men is required to operate either the M1 or the M3 set. The vigorous stirring that is required makes it necessary for the men to relieve each other at short intervals.

Field impregnation can be accomplished indoors or outdoors. Adequate facilities for hanging or spreading the clothing so it will dry must be provided. Clothing should not be exposed to direct sunlight while it is drying, because this will cause decomposition of the impregnite and also result in discoloration of the fabric.

TABLE 4-1

Schedule of Tests for Protective Clothing

Condition of clothing	Climate	Reimpregnation intervals	Minimum amount of issue visually inspected (%)
Being worn; not contaminated	Tropical, temperate, or cold	1 week's wear or one laundering	10.0
In storage; not contaminated	Tropical	3-month maximum	0.5
In storage; not contaminated	Temperate to cold	6-month maximum	0.5
Garments exposed to blister gas vapor	All	Immediately upon exposure or as soon as practicable	All exposed clothing must be reimpregnated

4B2.01 SPECIAL SITUATIONS

The materials that are described in the preceding section provide adequate physical protection for the individual. It is necessary, however, to have some supplementary items for self-aid and for special operating conditions such as amphibious landings. These items are discussed in the following paragraphs and in Appendix A, as referenced.

4B2.02 PROTECTION AND TREATMENT SET, CHEMICAL WARFARE AGENTS, M5A1

The M5A1 protection and treatment set is a kit that is carried in the protective mask carrier. It provides necessary materials for self-aid against CW agents. As shown in paragraph A35 of Appendix A, the kit contains three tubes of M5 protective ointment, one tube of BAL eye ointment, and one atropine tartrate injection that is packaged in a waterproof, metal container. The uses of these materials are as follows.

1. PROTECTIVE OINTMENT. The M5 protective ointment neutralizes blister gas. Precautions must be taken to keep the ointment out of the eyes. It may be applied to any other area of the body before exposure to blister gases, and it is effective against contamination of the skin by G-agents. For example, the ointment may be applied to exposed areas of the face and neck. It may be applied to areas of the skin that are exposed by torn or improperly fitting clothing. It is also used for (a) first-aid in the decontamination of any area of the body surface (except the eyes) after exposure to blister gases and (b) emergency decontamination of small areas on clothing and items of individual equipment such as weapons. To be effective on the skin, the M5 ointment must be applied within two minutes after exposure.

In the treatment of an area of the skin that has been splashed with a blister agent, the first step is to pinch-blot the CW agent from the skin with cloth or absorbent paper. Then, M5 ointment is rubbed vigorously on the skin, and after 30 seconds, the excess is removed. A final coating of the ointment is then applied and allowed to remain.

2. BAL EYE OINTMENT. BAL ointment is suitable for use in the eyes to counteract the effects of arsenical agents (L, ED, MD, and PD). When using the ointment, the individual's hands should be free of contamination. The eyes should first be flushed with water for about 30 seconds, but if there is eye pain, the BAL ointment should be used immediately. This is done by squeezing a small amount of ointment into a corner of each eye, and spreading it under the eyelids by gentle massage. Eyelids and eyelashes can be treated by blotting off the agent, spreading BAL over the area, and wiping off the BAL at once with a clean cloth.

3. ATROPINE TARTRATE INJECTION. An atropine tartrate injection consists of a sterile, collapsible tube that has a needle attached. The tube contains a solution of atropine tartrate. The assembly comes with a wire that is inserted in the tube of the needle. When the wire is pushed inward, it punctures the seal at the top of the tube. The wire is then withdrawn, and the injection is made. This unit is provided for self-aid against G-agents only. Symptoms such as an unexplained running nose, tightness in the chest, or pinpoint eyes, (dimming vision) call for an injection of one shot. The injection should be made deep into a large muscle of the thigh, buttock, or upper arm. After injection, massage the area to speed the action of the drug. About eight to ten minutes are required for the atropine tartrate to take complete effect. After the first shot, two additional shots may be given by a hospital corpsman as a first-aid measure. More than 3 shots should be administered only under the supervision of a medical officer. The empty tubes should be attached to the patient's label to avoid overdoses. Dryness in the mouth indicates that enough atropine tartrate has been injected. Other details concerning first-aid procedures will be found in paragraph A35 of Appendix A.

4B2.03 PROTECTIVE MASK WATERPROOFING SETS

During landing operations, personnel who are going ashore will require some protection of their masks against water. Two waterproofing sets (paragraph A25 of Appendix A), one for each type of mask, are available. For the M9A1 mask, the designation is "Bag, Waterproofing, M 1," and for the LWS mask, the designation is "Waterproofing Set, C 3." For details see Appendix A.

4B2.04 INDIVIDUAL PROTECTIVE COVERS

In addition to the protective clothing that is described in the preceding section, a special cover is provided. This is described in detail in paragraph A27 of Appendix A. It

is designed to protect the head and body from liquid spray contamination. Personnel of the Shore Establishment are not expected to be in the open during a CW attack; but, because this item can also be used as a bag to hold contaminated clothing for transport and decontamination, it is maintained in present allowances.

4B2.05 PROTECTIVE DRESSING FOR SHOES

A special dressing is provided for treatment of shoes to make them resistant to gases such as the mustards. For this purpose, a 2-oz can (M 1) or a 4-oz can (M 2) of dressing (paragraph A32 of Appendix A) that is known as "leather dressing, gas-resistant," is required. The material is rubbed by hand into the leather of shoes. One treatment will resist a liquid mustard agent for approximately 2-1/2 hours.

4B3.01 SELF-PRESERVATION DURING A NUCLEAR ATTACK

When an advance warning of a nuclear attack is given, the best procedure is to go to specified shelters without delay and remain there until proper authority has indicated that it is safe to emerge. Full protection against radiation may not be readily available (except when special underground shelters are provided), but even partial protection will reduce the number of casualties.

If no warning is given, the first indication of an attack may be a bright flash of light, ground shock or tremor, or a rising column of dirt or water. Almost instant reaction by individuals may be required to assure self-preservation. Ducking under a table or some other cover indoors, or into a trench or ditch if out-of-doors, provides shelter against some of the thermal radiation, reduces somewhat the dose of initial nuclear radiation received, and protects personnel against flying missiles. Even getting behind a pile of earth or a stone wall provides some sheltering. If no better opportunities offer, personnel should drop to the ground face down and cover their faces and hands as completely as possible. The hazard from flying missiles that accompany the blast wave may persist for ten seconds or more.

Residual radioactivity after an AW or RW attack can produce many more casualties if necessary precautions are not observed. Things to do and things to avoid may be summarized as follows.

1. THINGS TO DO.

(1) When an alarm is sounded, personnel shall get their masks ready and proceed to a designated station or shelter.

(2) When an attack occurs without warning, each individual shall throw himself face down against a bulkhead or wall; under a table, desk, or bench; in a ravine, ditch, or vehicle. He must cover himself with anything at hand and remain shielded until heavy debris has stopped falling.

(3) If not a casualty, each individual shall report (a) to his duty station or (b) for decontamination if so ordered.

(4) Personnel shall administer self-aid and give first aid.

(5) If injured, an individual shall report to a first-aid station.

(6) Personnel who are in the open subsequent to an attack shall don masks, adjust clothing, and, if possible, keep upwind from the possible fallout. If not in the immediate blast area, personnel will have some time to either get out of the path of the fallout or seek a shelter that provides radiation shielding.

2. THINGS TO AVOID.

(1) Avoid eating, drinking, smoking, chewing gum, or doing anything else that requires putting the hands to the mouth.

(2) Refrain from eating foods or drinking water from sources that have not been approved by competent authority.

(3) Avoid stirring up dust unnecessarily in contaminated areas.

(4) Avoid entering hazardous areas when not required to do so by duty assignment.

4B3.02 SELF-PRESERVATION DURING A BW ATTACK

Organized countermeasures against BW attack are based on decisions that are made by trained medical personnel. Self-preservation is largely a matter of compliance with orders and instructions, including special sanitary precautions and programs of inoculation and therapy. In addition, the individual must observe various safeguards in order to achieve a higher degree of safety. A few of these safeguards are summarized as follows.

(1) Masks shall be worn until an order is received for their removal, and personnel shall remain in shelters as directed. Personnel must keep upwind from suspected BW clouds as much as possible.

(2) Personnel shall report for BW decontamination when directed and have cuts and wounds treated as promptly as possible. They shall change to clothing that is known to be noncontaminated as soon as possible.

(3) Personnel shall keep out of contaminated buildings and areas unless entry is required by duty assignment.

(4) Subsequent to attack, personnel shall eat only approved foods, if such limitation is possible. Packaged foods will be safe to

use provided the outer surfaces have been decontaminated. This may be done by washing the package in a chlorine solution that is made by dissolving a handful of bleach in a half gallon of water.

(5) Personnel shall drink water only from approved sources. If the only available source is suspected to be contaminated, the water shall be boiled for 10 minutes and decontaminated by the addition of three iodine tablets per quart. If iodine odor is strong after 10 minutes, another 20 minutes must elapse before the water is drunk; if iodine odor is weak or absent, the water must be discarded and the process repeated with more than three tablets. It possible water should be boiled prior to treatment with iodine as an additional safety precaution.

4B3.03 SELF-PRESERVATION DURING A CW ATTACK

During a CW attack, the relative effectiveness of self-aid and first aid depends on (a) prompt recognition of the attack; (b) rapid institution of protective measures; and (c) knowledge of, and ability to use, available protective equipment and facilities. A few precautionary measures that must be followed in the advent of a CW attack are listed below.

(1) Masks shall be put on immediately after the warning has been sounded and kept on until the "all clear" has been given. This is the first line of defense. It is unsafe to rely upon odor to detect CW agents. When in doubt, masks must be donned.

(2) Unless under special assignment, personnel shall proceed to the shelter upon warning and shall remain there until the "all clear" has been given.

(3) When the eyes, face, and neck are contaminated by a liquid CW agent, individuals shall hold their breath and decontaminate and treat their eyes before donning masks. However, if considerable time will be required to decontaminate the face (more than a minute), it is better to don masks immediately and proceed to an area where masks can be removed and decontamination procedures can be undertaken.

(4) Personnel shall effect self-aid and first aid and continue duties when possible. Contaminated clothing shall be cut away and discarded. The skin must be decontaminated and treated.

(5) Masks shall be worn in enemy smoke.

(6) Until medical aid arrives, casualties must be made comfortable, kept warm and quiet, and, if necessary, given artificial respiration.

(7) During and subsequent to an attack, only approved foods shall be eaten. When the outer coverings of packaged food are suspected to be contaminated, they must be decontaminated by washing them in chlorine solution. Only approved water shall be used for drinking. It may be necessary to bring pure water supplies into the contaminated area.

(8) Unless entry is required by duty assignment subsequent to attack, personnel shall stay out of contaminated areas.

Self-aid differs somewhat according to the various CW agents that are employed. First aid consists of (a) assisting others in carrying out self-aid measures, (b) administering artificial respiration and treatment for shock, and (c) removing casualties from contaminated areas as required. Recommended procedures may be summarized as follows.

1. BLISTER GASES. Self-aid procedures include (a) flushing out the eyes with water when necessary; (b) using BAL eye ointment if there is eye pain; (c) decontaminating the face, ears, and neck when necessary, and putting protective ointment on exposed areas of the skin; (d) removing droplets of agents from the skin, and applying M5 ointment; and (f) decontaminating or discarding contaminated clothing.

2. NERVE GASES. Speed is the first essential step for self-preservation, and self-aid must be accomplished within five minutes. Self-aid includes (a) flushing liquid from the eyes with water; (b) decontaminating the face, ears, and neck with soap and water if available, and using protective ointment; (c) removing droplets of the agent from the skin; (d) taking one or more atropine shots when early symptoms develop as described in paragraph 4B2.02; and (e) decontaminating or discarding contaminated clothing.

3. BLOOD GASES. Self-aid includes (a) moving to a place where the air is not contaminated, (b) blotting off any droplets that have made contact with the skin, and (c) removing and airing clothes that have come in contact with the liquid agent.

4. CHOKING GASES. Self-aid includes (a) assuring that the mask is worn properly, (b) loosening the clothing, (c) keeping warm, and (d) taking nonalcoholic stimulating drinks when the mask can be removed. No

special self-aid should be necessary if masking has been prompt.

5. VOMITING GASES. Self-aid includes (a) wearing the mask in spite of coughing, sneezing, and salivation, and (b) lifting the mask only to vomit. If these precautions are observed, recovery should be prompt.

6. TEAR GASES. Self-aid includes assuring that the protective mask is properly worn. After the attack (gas cloud) has passed, the procedure is to unmask, face the wind, loosen clothing, blot (not rub) the eyes, use water to wash contamination from the eyes, and use soap and water to wash contamination from the skin.

7. SCREENING SMOKES. Self-aid, after unmasking has become possible, includes the use of water to remove such agents as sulfur trioxide and titanium from the body; the eyes should be irrigated if necessary. If white phosphorus has been employed, those areas where particles of the agent have lodged should be kept wet with water, mud, or wet cloths, and the particles should be removed while they are still wet.

8. INCENDIARIES. Self-aid includes (a) using a first-aid dressing to cover any area of the skin that has been burned or broken and (b) dealing with white phosphorus particles in the manner that is described in the preceding paragraph.

All of the preceding self-aid and first-aid measures are concerned with personnel in the field. When personnel come in contact with CW agents, it is desirable that they be processed through decontamination stations as soon as possible. Casualties will be decontaminated at the aid station. When personnel are more seriously injured, first aid and decontamination will be provided, pending the time that they can be removed to hospitals for further treatment.

4B3.04 PERSONNEL DOSIMETRY

Personnel dosimetry is important at the time of attack as a means of checking on dosages of total radiation, including initial radiation that is received by individuals. After attack, dosimetry is important as a means of determining doses of radiation that have been accumulated by individuals at all stages.

During recovery operations, personnel dosimetry is of great importance regardless of the calculated risks that may be assumed. It is the basis for making estimates and decisions of the following types.

(1) After a nuclear burst has taken place, dosimeter readings will provide a basis for the estimation of probable casualties and a determination of the personnel who should be evacuated immediately.

(2) Dosimeter readings are also the key that is used in the determination of (a) the permissible stay times of work parties in areas where residual radiation is present, (b) the individuals who have received the maximum acceptable dosages, and (c) the individuals who may be safely assigned to further stay times in contaminated areas.

4B3.05 MEDICAL AID AND EXAMINATIONS

Whether an attack is made with AW, BW, or CW agents, or a combination of all three, the importance of dispersed medical facilities to the individual is paramount. First-aid teams and stations on, and about, the rescue perimeter provide for early emergency treatment and evacuation. Personnel may be monitored, and decontaminated when necessary. Personnel who require further medical aid may then be sent to emergency hospitals or permanent hospitals that are beyond the support perimeter.

The medical support groups will provide for medical treatment and arrange for evacuation. In the event of a nuclear attack, the surviving medical personnel will be so overwhelmed with casualties that evacuation of wounded will of necessity be delegated to less burdened personnel under the supervision of the medical department.

Regular and special medical examinations become increasingly important after an ABC attack. If BW agents of known identity have been employed, programs of inoculation may be required in some instances and programs of drug therapy in others.

PART C. GROUP PROTECTION

Section 1. SELECTION, PLACEMENT, AND ALTERATION OF STRUCTURES

4C1.01 GENERAL POLICIES

Because protection of personnel is of paramount importance, the policy of the Navy is to plan protective shelters that will be functional to the highest degree. To accomplish this objective, the plans must be based not only on a recognition and understanding of ideal protection, but on methods and techniques that are practical and feasible. The degree of protection to be provided depends on factors that vary with the type, size, location, and cost of individual structures.

1. EXTENT OF PROTECTION. Although complete protection for all personnel is not feasible, the policy is to plan some protection, within budget limits, for all personnel at every activity. Thus, defense measures are intended to reduce to a practical minimum those personnel risks that can not be eliminated. Because it is impossible to determine in advance the exact type of attack that might be launched against a shore activity, all probable types must be considered, and an all-purpose protection must be designed. It is possible to evaluate a potential threat by a target analysis of the area and determine the critical weapon effects. When this has been completed, major efforts should be directed toward the reduction of hazards. For example, an activity, because of its location in relation to a potential target, might be undamaged by blast or fire and yet heavily contaminated by fallout. Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8, presents composite criteria for the provision of maximum protection within established limits.

The practical degree or maximum feasible protection for most personnel would include:

(1) Partial or complete shielding of personnel from contamination by CW and BW agents, and from heat and nuclear radiation;

(2) Limited protection from flying shrapnel;

(3) Limited protection from flying debris; and

(4) Limited blast protection. It will not be possible to provide everyone with the same degree of blast protection, because of the wide variation in types of structures at the various shore activities. It will be possible by prudent planning to considerably reduce the risks to which personnel would otherwise be exposed.

2. ASSUMPTIONS. The following assumptions are the basis for planning.

(1) An enemy may use AW, RW, BW, CW, or HE weapons, or any combination thereof.

(2) Sufficient advance warning will be given so that personnel can be evacuated or can take refuge in shelters. If they enter shelters, sufficient space will be available for each person.

(3) The entire activity or local area will be affected by the attack, and no area in the immediate vicinity will be left uncontaminated.

(4) Full protection against BW and CW agents will be provided only for command and emergency operations teams. Full protection means that the air will be filtered and masks need not be worn in shelters. Personnel may have to remain in shelters for extended periods of time.

(5) Partial protection against BW and CW agents will be provided for all other personnel. Partial protection means that the air in shelters will not be filtered and masks will be required. The personnel involved will be unable to leave the shelters during or immediately after an attack; they may have to remain in the shelters for three hours or more. In fact, in the event of an AW attack, personnel may not be able to leave the shelters at the end of three hours because of radiological contamination. The shelters, however, can be opened for ventilation.

Shelters should be located as close as possible to points where personnel are likely to be at the time of warning. Routes to shelters should be clear of obstructions and should not run through narrow passageways or other potential bottlenecks.

4C1.02 PRINCIPLE OF DISPERSAL

Dispersal is one of the most effective means of reducing vulnerability to enemy attack. The two forms in which dispersal may be utilized are dispersal in space and dispersal in time. A detailed treatment of this subject will be found in Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8.

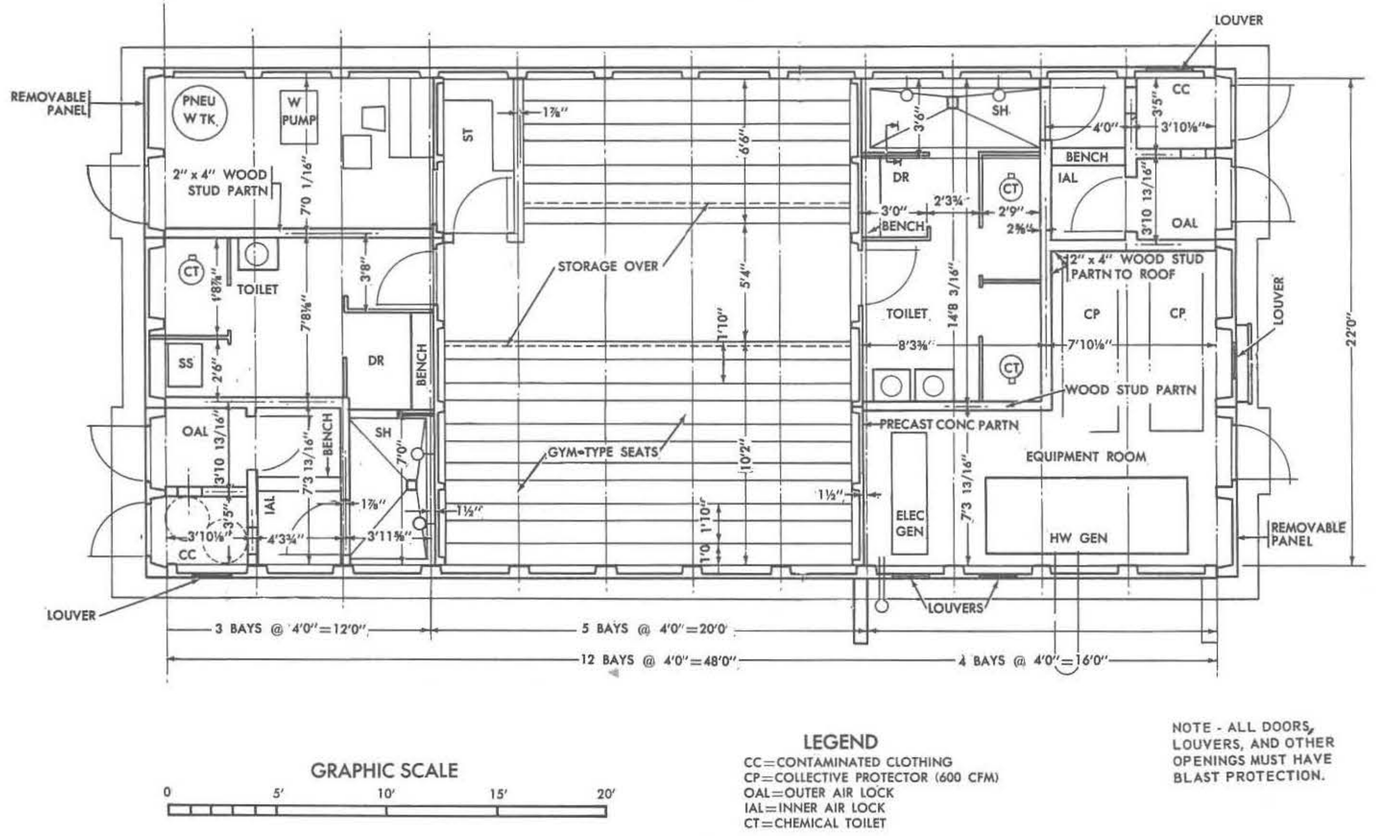


Figure 4-6. A Typical Single-Purpose Shelter

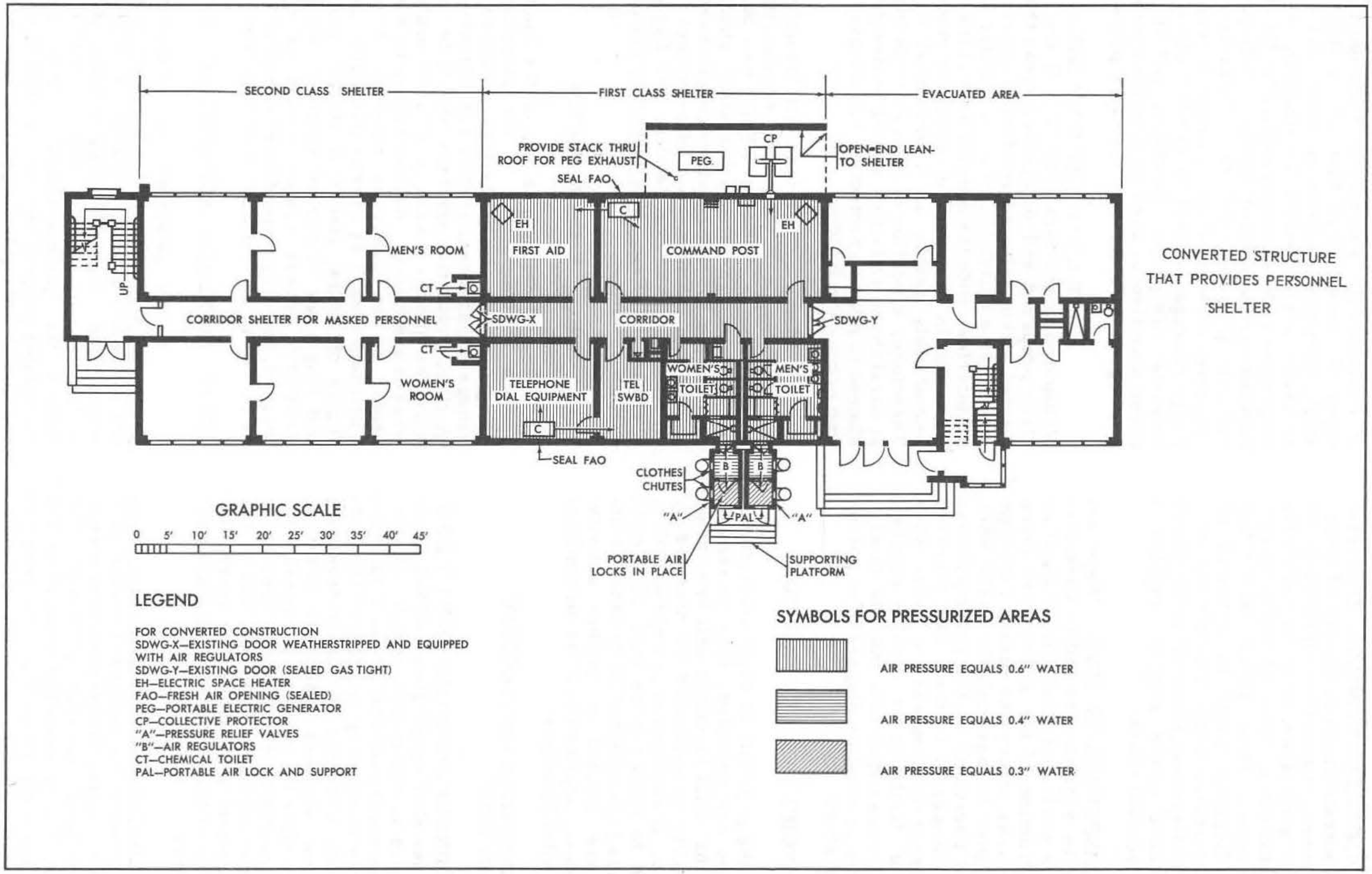


Figure 4-7. A Typical Multipurpose Shelter

1. DISPERSAL IN SPACE. Dispersal in space (decentralization) is the act of separating personnel, materials, equipment, or facilities from each other, or from a probable target area, for the purpose of reducing vulnerability to enemy action. During World War II, adequate dispersal could be achieved by separating structures within a single activity. This degree of dispersal, however, is no longer adequate because newer weapons require a dispersal of several miles.

2. DISPERSAL IN TIME. Dispersal in time may be regarded as split, alternate, or successive work shifts that are arranged so that only a fraction of the entire work force will be in an area at any one time. This type of dispersal may be particularly useful when protection of personnel is the principal consideration. Dispersal in time can increase the effectiveness of dispersal in space when protection of facilities is equally critical. Personnel who are not on duty must be in adequate shelters or must be dispersed in spaces as discussed above.

4C1.03 PRINCIPLE OF DUPLICATION

By the principle of duplication, duplicate facilities are provided, thus increasing the chances that vital functions will be carried on if one facility is destroyed or disabled by enemy action. If duplication is impracticable, plans should be made for the work of certain vital facilities to be carried on by other facilities that are located at another activity. Because of cost, duplication must be confined to the most vital facilities.

4C1.04 PERSONNEL PROTECTIVE SHELTERS

1. SINGLE-PURPOSE SHELTERS. Single-purpose shelters (Figure 4-6) are especially designed to resist ABC attack. Shelter is the primary purpose that these structures serve. Areas in existing reinforced concrete or steel frame buildings should be developed for protective shelters whenever possible, because they offer the most economical solution to the problem of collective protection. Single-purpose shelters, however, will be required when existing facilities are inadequate or can not be readily altered to include personnel shelters.

Single-purpose shelters are ideal bases of operation for command center personnel, control posts, decontamination teams, and other emergency recovery personnel. The ready availability of essential equipment and gear within the shelters is likely to result in important savings in time and less possibility of confusion in emergency situations. The types of construction that are suitable for single-purpose shelters include: (a) earth-covered, prefabricated ammunition storage magazines with reinforced end walls; (b) earth-covered, prefabricated buildings with precast concrete panels; and (c) poured-in-place concrete, blast-resistant personnel shelters. Large corrugated steel or reinforced concrete culverts with proper entrances and an earth cover may also be used to provide a substantial degree of blast and radiation protection.

2. MULTIPURPOSE SHELTERS. Multipurpose shelters (Figure 4-7) are especially prepared and designated areas that are located within selected reinforced concrete or steel frame buildings. Such a shelter should not interfere with the normal uses of the buildings, but in the event of attack it should be immediately usable as a personnel shelter. Therefore, a portion of each suitable building at naval shore activities should be designed or altered to provide protection for the personnel who occupy the building.

These conversions will usually cost considerably less than the construction of single-purpose shelters. When a new building is being designed, consideration should be given to the special requirements that are necessary for the protection of personnel during an ABC attack. For details, see <u>Personnel Shelters and Protective Construction</u>, NAVDOCKS TP-PL-8.

4C1.05 PROBLEMS OF ACCESS

Accessibility is one of the most important considerations in the planning and designing of personnel shelters. Because large groups of personnel usually can not assemble quickly, protective shelters should be located near the places where personnel ordinarily work or are housed. Access routes to shelters should be as direct as possible. Potential bottlenecks, such as narrow passageways, long flights of stairs, stacks of stored materials, and long rows of parked vehicles, should be avoided. Access routes should be clearly marked, and diagrams of marked routes should be posted in all working or living areas.

4C1.06 SHIELDING AGAINST RADIATION

In the selection and construction of personnel shelters, the problem of shielding the occupants against radiation is of primary importance. Good shielding is achieved when a thickness of material that is sufficient to reduce the gamma-radiation dose rate to acceptable proportions is interposed between the individual and the source of radiation.

A variety of materials will provide the desired protection. Each of them has a half-thickness, which is that thickness of absorbing material necessary to reduce the dose rate of the radiation by one half.

Figure 4-8 illustrates the shielding effect of three half-thicknesses of material. The initial gamma-radiation dose rate is 400 r. Upon passing through the first half-thickness, this dose rate is reduced to 200 r; it becomes 100 r after passing through the second half-thickness; and it is reduced to 50 r after passing through the third half-thickness.

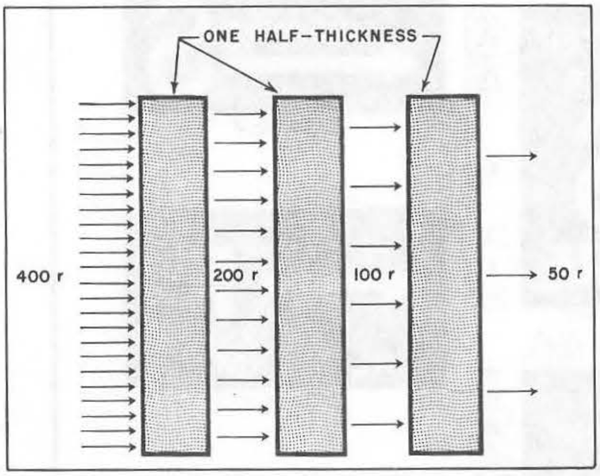


Figure 4-8. Reduction in Dose Rate of Gamma Radiation Provided by Three Half-Thicknesses of Shielding Material

Half-thicknesses vary among materials that are often used for shielding purposes. For initial gamma radiation, half-thicknesses have been estimated as follows.

Material	Thickness (in.)
Steel	1-1/2
Concrete	6
Earth	7-1/2
Water	13

The thicknesses that are necessary to provide varying degrees of protection against fixed amounts of initial gamma radiation can be readily computed. The shielding properties of any material are directly proportional to its density.

The half-thicknesses that were previously discussed apply to initial gamma radiation rather than residual radiation. In general, half-thicknesses are less for residual radiation because gamma radiation from fallout is not as penetrating as the initial gamma radiation from a burst. More detailed discussion on half-thicknesses is contained in Effects of Nuclear Weapons, which was prepared by the Department of Defense and published in June 1957 by the Atomic Energy Commission.

The estimation of the shelter that a building will provide is rather complicated and depends on several factors, including (a) the number of building openings, (b) whether the area is above or below ground, and (c) the type of roof. Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13, presents a procedure for the estimation of the sheltering capacities of buildings.

4C1.07 SPECIAL MARKING OF AREAS

Locations of, and directions to, shelter areas and locations of fire alarms, fire stations, warden posts, and first-aid stations should be indicated by special markings. Shelter areas should be clearly marked so that occupants will have no doubt concerning the area limits. Directional signs should indicate clearly to all persons the routes of travel to the nearest shelter area. Building entrances should be appropriately marked so that the on-street population will know how to get to the shelter areas that have been reserved for its protection.

Examples of typical signs that are used for the aforementioned purposes are shown in Figure 4-9. The type of materials and the color of the paint that are used in the construction of the signs are optional. For indoor use, any durable material with white letters on a dark background is suitable. Signs that are made of weather-resistant material with high-visibility yellow or luminescent yellow letters on a dark background are recommended for outdoor use. Stencils and/or decalcomanias may also be used.

4C1.08 ALTERATION OF STRUCTURES

Many existing buildings must be altered for use as personnel protective shelters to meet the shelter requirements. Because of the differences in construction, geographical location, environmental factors, and other considerations, each building must be studied from an engineering standpoint, using criteria that are presented in Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8.

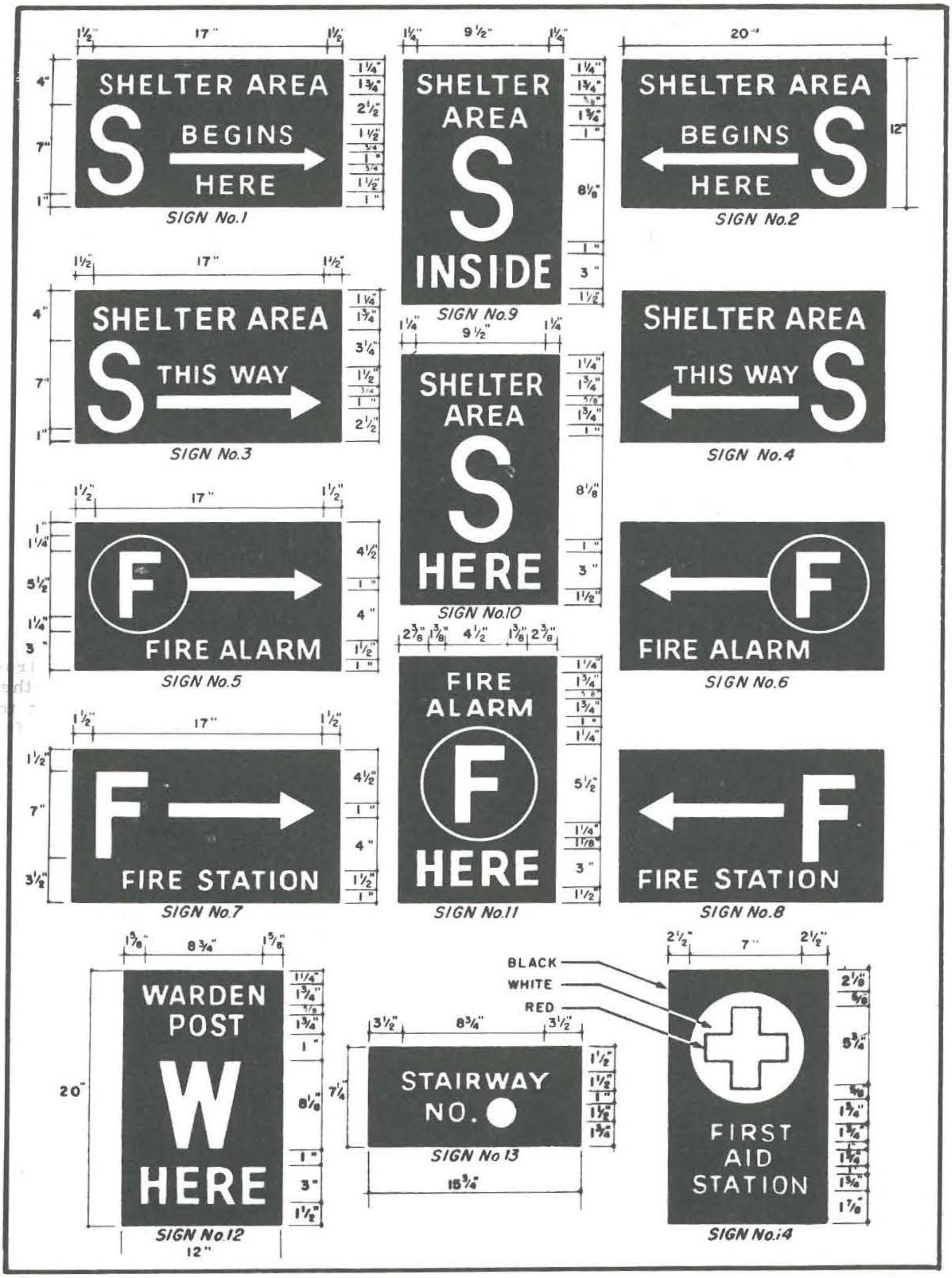


Figure 4-9. Special Signs

4C2.01 REQUIREMENTS

The number and types of personnel shelters will vary from activity to activity. This does not mean that every activity will require all of the types that are discussed. These types are mentioned as the types of facilities that will be required by recovery forces. If they are not available, it will be necessary to improvise at the scene of the disaster either in existing buildings or at locations that are outside of the contaminated areas.

4C2.02 COMMAND AND COMMUNICATION CENTERS

The command and communication center, when used in ABC warfare defense, will be the nerve center for all emergency operations. Properly equipped, it should provide complete command facilities, including shelter, subsistence supplies, and facilities for decontaminating personnel. In general, it will be the focal point for direction and control of the entire recovery force.

To enable key personnel to exercise command effectively, the center must be set up to facilitate rapid and correct evaluation of the emergency situation. To make such an evaluation will require an adequate means of acquiring information. The communications system must therefore be an integral part of the center, and should be tied in with all shelter areas--the mobile defense force (both while in the field and at a control point) and the district control center. The use of communications equipment will require that the center be pressurized and sealed so that masks will not be needed.

4C2.03 DISASTER CONTROL CENTERS

The disaster control center will provide complete support for teams of the disaster control organization. Devices to permit rapid display and evaluation of information that pertains to the emergency situation should be included. Such equipment will include devices that display the distribution, strength, and use of disaster control forces, a graphic plot, message control, and a summary status board. The center should also include a shelter area, subsistence food and water, supplies, and equipment. This center must be equipped with adequate storage space for the supplies, tools, and equipment that are necessary for its proper functioning. To facilitate ready issue, storage must be well organized.

4C2.04 FIRST-AID CENTERS

The first-aid center will provide facilities for treatment, registration of survivors, and evacuation of casualties from the area. Support that will be provided by the first-aid center will include shelter, subsistence supplies, decontamination materiels, and complete medical supplies. In addition, it will contain hospital equipment such as beds, treatment tables, sterilizers, and other medical equipment that is necessary for emergency treatment of the wounded. The first-aid center is not to be considered a hospital, because casualties that are brought to the center will be held and cared for only until they can be transferred to hospitals for further treatment.

4C2.05 MASK-TYPE SHELTERS

General-purpose shelters are those facilities that are assigned to provide protection for all personnel who are not a part of the emergency recovery forces. These shelters do not have air filtering or pressurization equipment to provide protection against BW or CW attacks; therefore occupants must wear masks. They are usually designed for three-hour occupancy without outside sources of air after which time outside unfiltered air can be used. Shielding for these shelters, however, should be the best that is obtainable, because long periods of occupancy may be required if fallout occurs. These structures will provide shelter for personnel and standby use for emergency crews. Storage space should be provided and stocked with limited amounts of first-aid supplies and emergency rations. Minimum cubage requirements of unventilated shelters for three-hour occupancy are discussed in Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8.

4C2.06 SPECIAL SHELTER EQUIPMENT

Several special items for use in the construction or alteration of a building for personnel shelters are described in detail in paragraphs A40 through A49 of Appendix A. The requirements for each varies with the type of shelter to be provided and with the operational function of the shelter.

4C2.07 OPERATIONAL REQUIREMENTS FOR SHELTERS

1. HEAT, VENTILATION, AND AIR FILTRATION. When ambient temperatures require, provision must be made to heat shelters. Heating capacity must be sufficient to

maintain a minimum operating temperature of 60° F. Ventilation must provide at least 5 cfm of filtered air for each operating person as well as sufficient air to cleanse the airlocks.

2. COMMUNICATIONS FACILITIES. Communications facilities in personnel shelters must be connected to the regular telephone system so that communications can be maintained with the command posts. Two-way radio equipment is desirable if the shelter is to house operating personnel.

4C2.08 FOOD AND POTABLE WATER

Emergency field rations must be provided for personnel during an attack. Drinking water must be furnished either through the normal system, a supply of bottled drinking water, or an emergency water system.

4C2.09 LIGHTING AND POWER

An emergency generator must be selected to supply emergency power. It must be one that will (a) respond quickly to demand and (b) have sufficient capacity to carry the entire essential electrical load of the shelter, including the load of ventilating and heating equipment, water pumps, and lighting circuits.

4C2.10 FUNCTIONAL SUPPLIES

Among the functional supplies that are required in personnel shelters are:

(1) Field rations and drinking water

(2) Chemical toilets

(3) Soap

(4) Paper towels

(5) Toilet tissue

(6) Fuel and lubricants for generators

(7) First-aid supplies

(8) Battle lanterns, flashlights, and batteries

(9) Coveralls (not used in unpressurized shelters)

(10) Emergency tool kits (includes shovels, crowbars, etc.)

(11) Masks (only if masks have not been issued to personnel)

(12) Nontoxic hand firefighting equipment

(13) Radiac gear.

Section 3. DESIGNATED SPECIAL AREAS

4C3.01 ASSEMBLY AREAS

An assembly area is an area that is specially designated as a rallying point from which controlled and orderly evacuation of nonessential personnel can take place. An adequate number of assembly areas must be planned and established, and each must be large enough for the assembly of approximately one hundred persons. The locations of the nearest assembly area and alternate assembly areas must be posted in all personnel protective shelters. Among the locations that are suitable for assembly areas are lobbies of large buildings, theaters, gymnasiums, and cleared areas outside of buildings. Monitoring teams must make certain that the level of contamination at an outside area is within allowable limits before permitting it to be used as an assembly area. It is important to select assembly areas that can be reached readily by transportation equipment.

4C3.02 EVACUATION ROUTES

A system of evacuation routes that lead from the assembly areas must be established as a part of the evacuation plan. These routes must be well known to all who are involved in furnishing transportation services. However, because preselected routes may be damaged or blocked by debris, it may be necessary for reconnaissance and monitoring teams to select and mark alternate routes.

4C3.03 SPECIAL DANGER AREAS

Special danger areas are isolated areas that have been determined to be too dangerous for the entry of nonoperating personnel. Such areas are highly contaminated, contain structures that are in imminent danger of collapse, or are particularly hazardous for other reasons.

Areas that have been determined to be special danger areas must be marked accordingly by monitoring and damage survey teams. The necessity for policing these areas depends on the urgency of such action and the availability of personnel for that purpose.

PART D. FACILITIES, SERVICES, AND MATERIALS

Section 1. WATER SUPPLIES

4D1.01 SURVEY OF FACILITIES

Water supplies may become contaminated either as a result of overt attack or covert action. Contamination may radiological, biological, chemical, or some combination thereof. In the event of an AW attack, contamination may result from the introduction of sewage into water mains.

Because decontamination of water may be difficult and perhaps impossible under existing circumstances (paragraphs 4A4.04 and 4A5.05) alternate sources of potable water should be located in anticipation of future need. Such sources may include wells, reservoirs, streams, and the water supply systems of nearby communities. The following general considerations apply to the use of water and water sources.

(1) If storage tanks are tightly covered, the water will generally be safe.

(2) Water in Lyster bags is safe if the bags are correctly closed and spigots are not contaminated. Individual protective covers that are drawn over the bag from the bottom and tied at the top will protect the spigot.

(3) Spring water should be protected by placing protective covers over the springs. With an average flow, springs should purify themselves in a short time.

(4) Well water is unlikely to become contaminated, except as a result of covert action.

(5) Protection for water in open streams, ponds, and lakes is not feasible. Large bodies of water are not likely to become heavily contaminated; the possibility of heavy local contamination, however, should not be overlooked.

Water supply systems should be mapped to show the location of filtration and pumping plants, mains, hydrants, pipes, and cutoff valves. Mapping will facilitate emergency repairs or bypassing when a portion of the system is damaged.

4D1.02 DAMAGE PROBLEMS

During an AW attack, serious disruption of distribution systems may be anticipated. Filtration, purification, and pumping facilities are almost certain to be impaired or destroyed. Because many pipes and mains will have been ruptured and some pumping facilities lost, water pressure may be seriously affected. In such an event, closing appropriate valves may restore pressures in parts of the distribution system that are still in operating condition.

Provision of special equipment for the maintenance of water supplies is an important phase of preparation to withstand a nuclear attack. The following items can be used to good effect where their employment is applicable.

1. POWER AND PUMPING EQUIPMENT. Auxiliary equipment will be required where pumping plants are electrically operated and would be out of commission if a general power failure occurred. The effects of such a failure can be forestalled by the provision of portable, auxiliary power generating and pumping equipment that is driven by a gasoline or diesel engine.

2. PIPE LOCATORS AND LEAK DETECTORS. Pipe locators and leak detectors have obvious uses whenever elements of a distribution system are damaged by bomb explosions. A properly dispersed emergency supply of these devices should be available.

3. PIPE AND FITTINGS. Supplies of pipe for temporary emergency repairs, together with standard couplings and fittings, should be provided at properly dispersed points. Special fittings, clamps, and couplings should also be provided.

4. FIRE HOSE. A limited supply of fire hose is necessary for firefighting and for installation between special fittings to connect still usable portions of a damaged distribution system.

4D1.03 CONTAMINATION PROBLEMS

The types of water supply contamination that may be anticipated are discussed in paragraph 3B3.04. Safeguarding against covert contamination is largely dependent upon the efficiency of the security system. Contamination that is due to overt action, however, must be anticipated. In either event, the first recourse is to draw upon outlying sources of uncontaminated water if available. Decontamination of water is discussed in Chapter 4, Part E, Section 10, and in Appendix C.

4D1.04 EMERGENCY WATER REQUIREMENTS

Emergency requirements for potable water for drinking and cooking are about one gallon per person per day. However, an additional and much heavier demand may be made for noncontaminated water that will be used in the decontamination of personnel. The minimum requirement for this purpose is approximately eight gallons per person per decontamination.

Contaminated water may be used for firefighting; therefore, firefighting capability will be limited by supply and pressure.

4D1.05 DISTRIBUTION SYSTEMS

In ABC defense, loop systems and gridiron systems are recommended for the distribution of water, as well as for fuels and steam. The general nature of such systems is shown in Figure 4-10. The loop system and gridiron system, through suitable valving, is advantageous because they make possible the continued use of a distribution system, even though a portion of the system has been damaged.

Increased use and improvement of loop and gridiron distribution systems are considered to be essential to ABC warfare defense. Both planned and existing systems should be examined critically to determine whether adequate loop or bypass lines are available. These should be provided in new systems, and in existing systems insofar as practicable. Systems should also be examined to determine the existence of adequate numbers of easily accessible and clearly marked valves with which damaged sections of the main or service connections can be isolated from the system. Valves should be installed and/or marked to provide for such isolation.

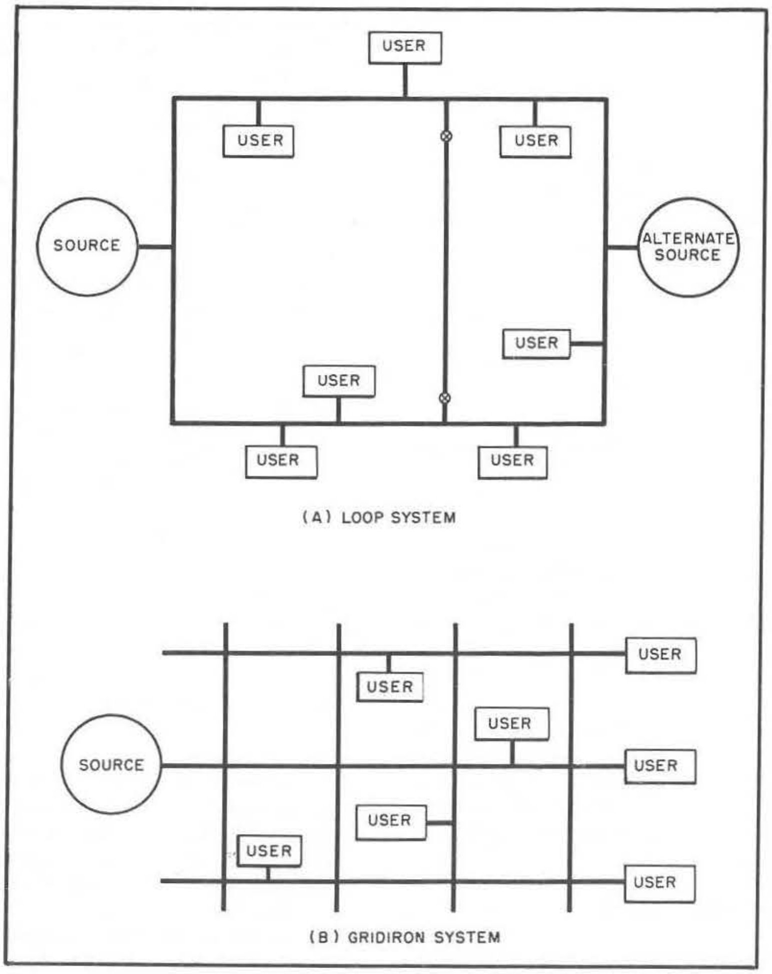


Figure 4-10. Loop and Gridiron Distribution Systems

Automatic sprinkler systems are widely and effectively used to extinguish "normal" fires that originate within structures. A special problem, however, would be posed by an AW attack because it is possible, if not probable, that a great many sprinkler heads might be activated at the same time. As a result, heavy demands would be placed upon the distribution system, and water pressure needed by firefighting teams might be reduced or lost. The capacity of the water system at a naval activity is rarely large enough to permit operation of all sprinkler heads at the same time. The water supply system of each activity must be evaluated against the possible demands, and decisions must be made on which portions of an existing sprinkler system should be inactivated, upon receipt of an alert, to preserve the usefulness of the system as a whole. Naval activities that are adjacent to water will have an unlimited source if pumping equipment is available. Every effort should be made to exploit this possibility.

4D2.01 GENERAL

Adequate power supplies are vital to the effective operation of naval shore activities. They are especially necessary during emergency operations subsequent to major disasters. Three principal methods might be used to assure adequate power supplies during emergencies; they are (a) provision of multiple independent systems, (b) duplication of facilities, and (c) mobile emergency plants. If the first two methods are employed solely for disaster control, they are impractical because of their extremely high cost and the possibility that even the additional systems or facilities will also be damaged. Therefore, they will not be further discussed in this publication. Mobile emergency plants are advantageous because they can be put into operation on short notice.

4D2.02 RAILWAY STEAM-ELECTRIC PLANTS

The largest mobile plants that are operated by the Navy are 10,000-kw, railway steam-electric generating plants. Each is made up of six cars and may be set up for operation on any level stretch of track 386 feet long that will support a wheel loading of 55,000 lb per axle. The cars that comprise the plant are a boiler car, turbine car, switchgear car, transformer car, gondola car, and boxcar.

4D2.03 MOBILE POWER UNITS

One type of mobile generating plant operated by the Navy is mounted on a steel railway car (Figure 4-11), which houses a supercharged, 3-phase, 60-cycle generator that is rated at 600 kw and 480 volts. Each unit is a complete plant with all the necessary auxiliaries, such as pumps, fuel and lube oil tanks, a starting air compressor, oil and water cooling radiators, an auxiliary engine generator, car heating equipment, and a main switchboard.

Other types of mobile equipment are shown in Figures 4-12 and 4-13. BUDOCKS Instruction 11310.2 includes a list of all mobile power units that are under the control of the Navy. This instruction also lists home ports, methods of securing, and operating characteristics of each unit.

4D2.04 SHIPBOARD DIESEL-ELECTRIC UNITS

The Navy YFP 10 floating power plant (Figure 4-14) was first conceived (a) as an emergency electric generating plant that would be adaptable for use by the maximum possible number of waterfront shore installations and (b) for use in occupied areas. The plant was built to operate independently or in parallel with the various Navy-owned electric power generating facilities. It may be used on occasions to (a) supplement the power that is supplied by public utilities or (b) deliver power to public utility electric transmission or distribution systems.

The plant has a normal rated net output of 33,120 kw (39,000 kva) at the switchboard

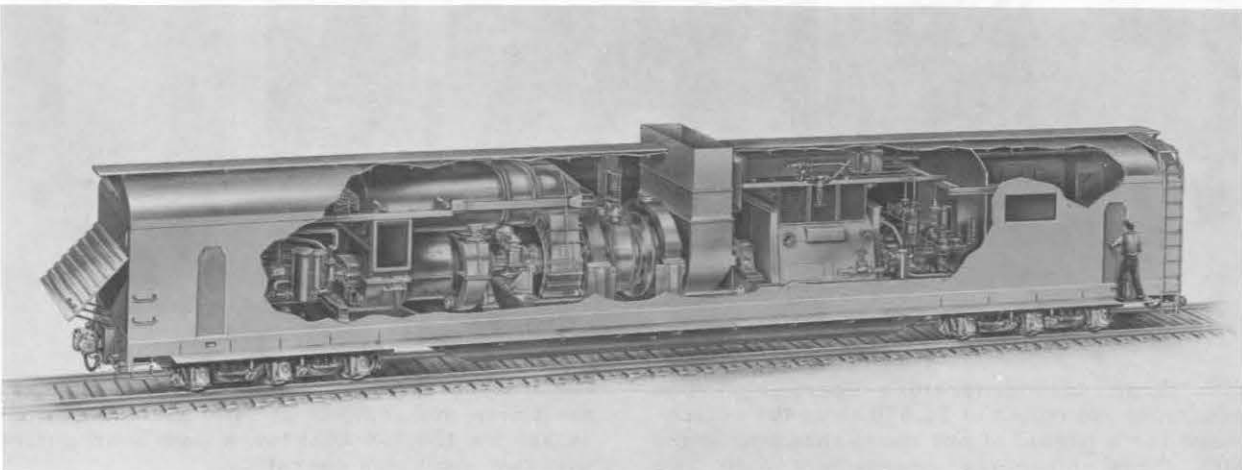


Figure 4-11. Rail-Mounted Gas Turbine Plant

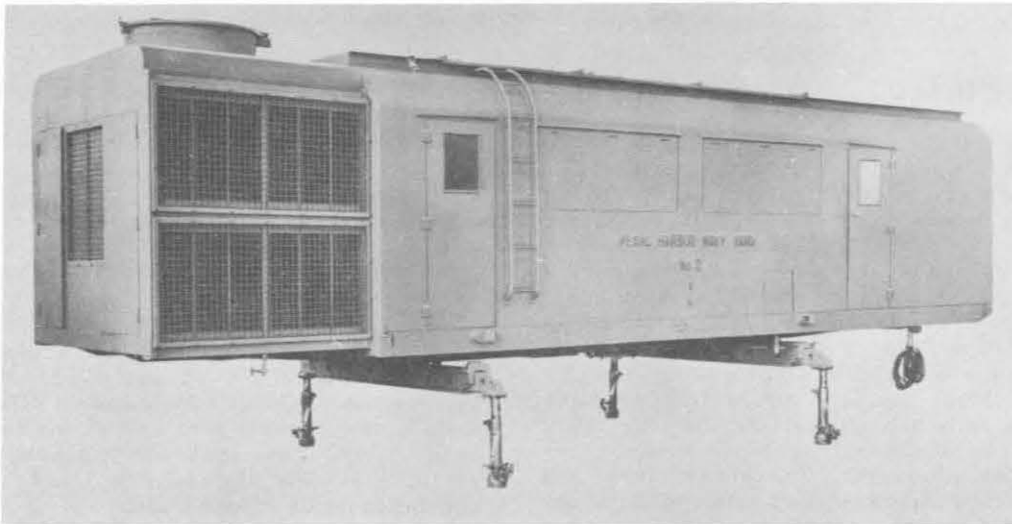


Figure 4-12. Mobile Diesel-Electric Plant, Heavyweight, 600 KW

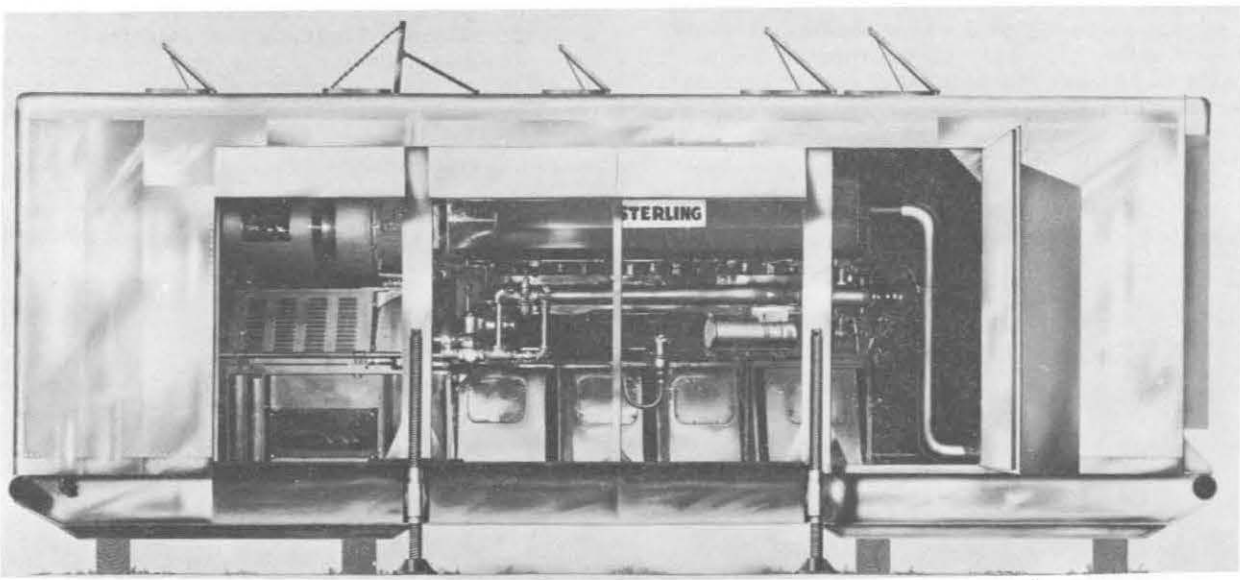


Figure 4-13. Portable Diesel-Electric Plant, Lightweight, 600 KW

with three turbogenerators operating. The maximum net output is 36,570 kw at the switchboard for a period of not more than two hours with three machines operating. With two machines operating, the normal net output at the switchboard is 22,080 kw (26,000 kva). The maximum net output at the switchboard is 24,380 kw (28,700 kva) for a two-hour period with two machines operating.

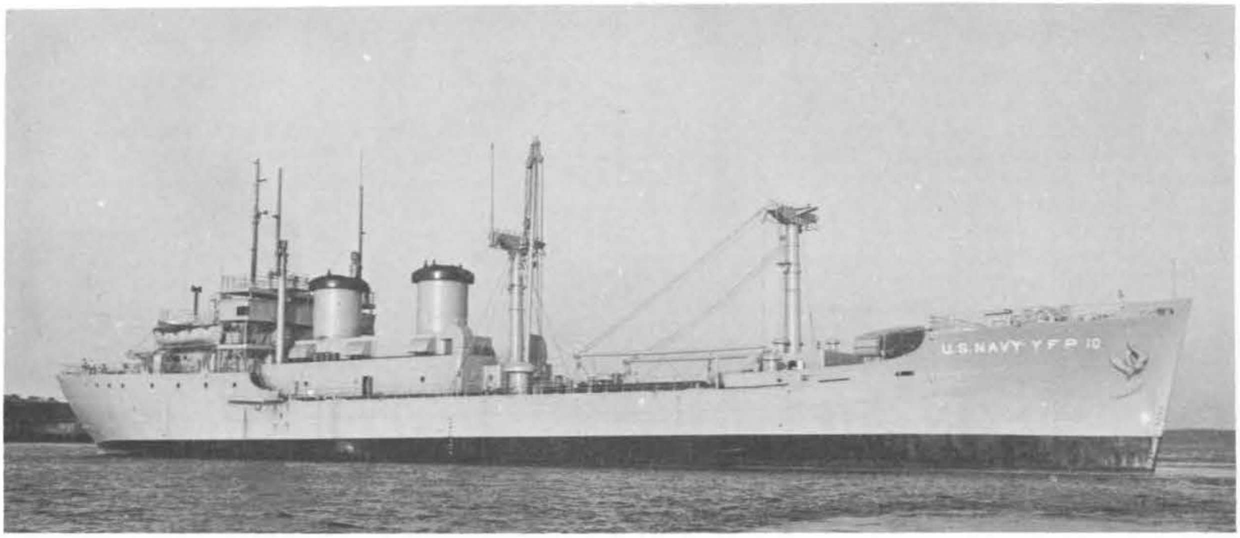


Figure 4-14. Floating Power Plant, YFP 10

4D3.01 PACKAGED FOODS

An emergency supply of packaged foods, or foods in sealed containers, is essential to ABC warfare defense. The advantage of using sealed containers is that contamination of the food by alpha or beta emitters or by BW or CW agents is not likely to take place as long as the containers remain intact. Gamma rays may pass through the containers and their contents, but their passage introduces no hazard to human health. Supplies of drinking water in sealed containers should also be on hand for the same reason.

1. TYPES OF CONTAINERS. Good protection may be provided by well-sealed wooden barrels, waxed paper cartons that are sealed to exclude air, or foil and cellophane wrappings that are similarly sealed. Unsealed wooden boxes or crates, untreated wrapping paper, and coverings of fabric give much less protection, especially against certain CW and BW agents.

2. CONTAMINATION. Contamination by ABC agents may be present on the outer surfaces of containers after an attack. If such contamination is suspected, the containers must be monitored for radioactivity and tested for CW agents. If neither procedure is possible or if contamination is verified, packages and containers must be carefully decontaminated before their seals are broken. A discussion of food decontamination will be found in Chapter 4, Part E.

4D3.02 DISPERSAL

Decentralization of emergency food storage facilities is a potential defense against loss of food supplies in ABC warfare attacks. This means of protection is particularly applicable to large stations occupying an extensive area. When food supplies have been destroyed or are too highly contaminated for immediate use, the most desirable alternative is to bring in additional supplies from outside areas. As a last resort, food may be decontaminated if no food replacements are available (Chapter 4, Part E, Section 9).

Emergency food service will be required by the end of the first 12 hours after an attack and will be required for another 24 to 48 hours. This phase of the emergency recovery operation is assigned to emergency messing teams of the supply element (paragraph 5C2.07). Such teams may be based at the affected activity or may be mobile units from another activity. Food may be stored in shelters as one means of achieving protection.

4D3.03 STOWAGE

Food supplies and facilities are subject to the same general hazards that threaten all material when it is under ABC attack. These hazards are not limited to the possibility of contamination, but also include the risk of physical destruction by blast or fire. Hence, emergency food supplies must be stowed as securely as circumstances will permit, but they must not be stockpiled and left in storage indefinitely. A system of regular and progressive use and replacement must be instituted.

Buildings that are reasonably blast-resistant will provide acceptable protection for food supplies that are in storage. Such buildings, however, will not exclude aerosols or radioactive dusts, although the foods will be protected if they are in tightly sealed containers.

PART E. DECONTAMINATION

Section 1. PURPOSES, PROBLEMS, AND PRIORITIES

4E1.01 PURPOSES

The basic purpose of decontamination is to remove or neutralize ABC warfare agents so the mission of the activity can be carried out without endangering the life or health of assigned personnel.

The purpose of radiological decontamination is to remove or shield the contaminant from personnel who are required to work in contaminated areas. On the other hand CW agents must be neutralized so they will no longer be a hazard to personnel, and BW agents must either be killed or sealed to surfaces.

4E1.02 PROBLEMS

Because decontamination requires considerable personnel, material, and equipment, the appropriate command must weigh the advantage to be gained against other requirements. Only the most urgently needed areas and equipment should be considered for decontamination, because personnel will be required for other duties, especially during the emergency phase of recovery. The longer decontamination can be delayed, the less severe the problem will be, because all ABC agents decay naturally. Exceptions to this rule are the surfaces that absorb the liquid of CW agents. It is doubtful, however, that such surfaces would ever be a critical factor in recovery operations.

Some of the special problems and conditions that are involved in decontamination are listed as follows.

(1) Removal of dry particles is relatively easy when they are retained on a smooth surface by the action of gravity alone.

(2) Removal of particles becomes difficult when they are retained on a surface owing to adsorption, or the action of forces between atoms or molecules.

(3) Given enough time, particles of a radiological contaminant may enter into chemical combination with the material that is contaminated, thus forming compounds that are analogous to rust on an iron surface. When this occurs, decontamination becomes more difficult.

(4) Porous materials, such as ropes, fabrics, and rough surfaces, absorb contaminants. Decontamination of such surfaces and materials is relatively difficult.

(5) Neutron-induced radioactivity differs from other types of radioactivity because it affects the interior as well as the exterior of a substance. It is usually conceded to be useless to attempt decontamination of materials that contain sodium or copper if the radioactivity of such materials is neutron-induced. The preferred procedure is to put such materials aside for a time and allow the radioactivity to decay naturally.

4E1.03 PRIORITIES

After an attack, data from ABC surveys will be used to determine the extent and degree of contamination. Contaminated personnel must be decontaminated as soon as possible; otherwise, additional casualties will probably be incurred. Before decontamination of installations, machinery, gear, access routes, and ground areas is undertaken, an appraisal of urgency must be made in the light of immediate and projected military requirements.

Decision as to the degree of decontamination that will be attempted must depend on circumstances and need. A contaminated bridge that is used only for the rapid passage of occasional vehicles might, for example, have a rather low priority as a structure to be decontaminated. If the same bridge is to be required by work parties, a rough decontamination should be undertaken as an initial step.

Because of differences in the missions of activities, no specific list of priorities is applicable to all activities. The following list is a possible priority order:

(1) Personnel,

(2) Active defense installations,

(3) Equipment that is used in recovery operations,

(4) Access routes,

(5) Areas around personnel shelters or living areas for personnel who are required to stay in a large contaminated area,

(6) Communication facilities,

(7) Taxiways and operations facilities on airfields,

(8) Messing facilities in support of facilities that are needed to complete recovery operations, such as transportation equipment pools, first-aid stations, and fire stations,

(9) Operational areas that are required to accomplish the mission,

(10) Water-treatment facilities,

(11) Dock and waterfront areas, and

(12) Shops and industrial buildings.

Both the priority for decontamination and the level of decontamination to be attempted must be given consideration. For example, only rough decontamination of vital equipment and facilities may be necessary or advisable during emergency recovery operations.

Section 2. DEGREE OF CONTAMINATION

4E2.01 GENERAL

The definitions of the levels of contamination vary with the types of agents that have been used. Radiological contamination is defined in terms of the dose rate in the area in roentgens per hour (r/hr). No precise definition of CW contamination is available, except to describe it as "very heavy," "heavy," "moderate," or "light." For BW contamination no qualitative or quantitative criteria have been developed, and an area is either considered to be contaminated or not contaminated.

Specification of a level of contamination provides a basis for the estimation of the decontamination effort that is required. It also indicates the time that personnel can remain in a contaminated area without becoming casualties.

4E2.02 RADIOLOGICAL CONTAMINATION

The level, or dose rate, of radiological contamination, measured in r/hr, diminishes with the passage of time. Therefore, countermeasures against radiological contamination might not be necessary, and a decision might be made to wait until natural decay has reduced radioactivity to an acceptable level.

The effectiveness of countermeasures against radiological contamination is expressed in terms of a residual number. This residual number is the decimal fraction of the radiation intensity that remains after countermeasures have been applied. Such countermeasures may consist of decontamination or the provision of shielding between personnel and the contaminant. Thus, if firehosing reduces radiation intensity from 100 to 15 r/hr, its residual number as a countermeasure is 15/100, or 0.15.

Obviously, the most effective countermeasure is the one that has the smallest residual number; however, securing smaller numbers may require excessive effort. Table 4-2 shows the relative effectiveness of various radiological countermeasures that can be taken in the reclamation of buildings and paved areas when no prepreparation of surfaces has been made. Table 4-3 gives the anticipated residual numbers when preparation of various surfaces has been effected.

4E2.03 BW CONTAMINATION

Because no rapid field method for the detection of BW agents is available, the measurement of the degree of this type of contamination is not feasible. The practical criterion is whether contamination does or does not exist. This criterion is not unrealistic because some infections can be caused by the presence of only a few organisms. As long as any positive evidence of contamination is indicated by field sampling, all personnel must wear masks and take other protective measures.

4E2.04 CW CONTAMINATION

The degrees of chemical contamination are designated as very heavy, heavy, moderate, and light; they are defined as follows.

(1) Very Heavy. Very heavy contamination exists when pools of the contaminating agent are present on a surface.

(2) Heavy. Heavy contamination is present when an almost continuous film of the contaminating agent is present on a surface.

(3) Moderate. Moderate contamination exists when numerous patches or droplets of the contaminating agent are present on a surface.

(4) Light. Light contamination is present when a few patches or droplets of the contaminating agent are widely scattered on a surface.

Chemical warfare contamination can be classified according to the three general types given below.

(1) Vapor and Aerosol Contamination. True vapors do not affect surfaces and therefore do not pose a decontamination problem. Conversely, aerosols will settle on surfaces and thus cause a light contamination that may require decontamination.

(2) Liquid Contamination. Contaminating agents in the form of droplets or splashes produce liquid contamination. If the surfaces that are subjected to contamination are made of porous materials, decontamination is difficult, because the agents will penetrate porous substances until they are beyond the reach of decontamination materials and methods.

(3) Particle Contamination. Particles of such agents as Adamsite (DM) and chlorocetophenone (CN) or hydrolyzed arsenicals are extremely small. These particles

TABLE 4-2

Effectiveness of Various Countermeasures on Unprotected Materials Subjected to RW Contamination

Building surfaces or paved areas	Radiation dose rate (r/hr)	Residual numbers for methods		
		Firehosing or street flushing	Firehosing plus scrubbing	Hot liquid cleaning
Asphaltic concrete	300	0.07	0.05	0.02
	1,000	0.03	0.02	0.01
	3,000	0.01	0.008	0.004
Portland cement concrete	300	0.04	0.03	0.02
	1,000	0.02	0.02	0.008
	3,000	0.008	0.006	0.003
Tar-and-gravel roofing	300	0.03	0.03	0.01
	1,000	0.02	0.02	0.009
	3,000	0.01	0.01	0.004
Composition roofing	300	0.04	0.04	0.02
	1,000	0.03	0.02	0.01
	3,000	0.01	0.01	0.005
Wood shingle	300	0.17	0.13	0.06
	1,000	0.10	0.08	0.04
	3,000	0.04	0.03	0.01
Galvanized corrugated steel	300	0.05	0.04	0.02
	1,000	0.02	0.01	0.006
	3,000	0.006	0.005	0.002
Smooth painted surface	300	0.04	0.03	0.01
	1,000	0.01	0.008	0.004
	3,000	0.004	0.003	0.001

can penetrate textiles, or adhere to various irregular surfaces, where they remain for a long time unless they are removed mechanically or neutralized.

The level to which the contamination must be reduced depends on the CW agent that is employed and the type of protective gear that is provided. For example, the Lct 50 respiratory dose from GB is 100 mg-min/m^3, while the Lct 50 dose through the skin of an unclothed person is 12,000 mg-min/m^3, and the Lct 50 dose through the skin of a person wearing ordinary clothing is 15,000 mg-min/m^3. Thus, if personnel can wear masks and still carry out their mission, decontamination need not be as complete as if they did not wear masks.

4E2.05 STAY TIME

In areas contaminated with radioactive material, for a given permissible dose, the only way stay time may be increased is by reducing residual numbers by decontamination, natural decay, or shielding. The smaller the dose rate to which personnel are exposed, the longer they will be available for duty. A detailed method for relating all of the stay time factors is contained in Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13.

The acceptable dose, or command dose, results from a command decision, which is based upon the number of casualties the command is willing to accept. The expected number of casualties, however, can be reduced by delaying entry into a contaminated area, because intensity of radiation will decline in time as a result of natural decay. Figure 4-15 is a nomograph that is used to (a) determine dose rates and (b) provide useful data for the computation of stay time. If the dose rate at 1 hour is 200 r/hr, the dose rate at 72 hours is determined by entering the "Time" column

TABLE 4-3

Effectiveness of Various Countermeasures on Preprotected Materials Subjected to RW Contamination

Building surfaces or paved areas	Residual numbers for methods of decontamination					
	Firehosing		Firehosing and scrubbing		Hot liquid cleaning	
	1 Pass	2 Passes	1 Pass	2 Passes	1 Pass	2 Passes
Alphaltic or tar-and-gravel roofing	N.A.*	N.A.	N.A.	N.A.	N.A.	N.A.
Prepared roll or composition roofing	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Metal surface	0.03	0.01	0.01	0.003	0.01	0.003
Wood surface	0.03	0.01	0.01	0.003	0.01	0.003
Asphaltic concrete	0.10	0.03	0.03	0.01	0.03	0.01
Portland cement concrete	0.10	0.03	0.03	0.01	0.03	0.01

*N.A. means "not applicable"

in Figure 4-15 at 72 hours and projecting a straight line through 200 r/hr in the middle column until the line intersects the "Dose Rate" column. Thus, the dose rate at 72 hours is found to be 1.16 r/hr. (See also Appendix E, Figure E-21.) Further information on stay time will be found in Appendix E, Figure E-19.

Stay time in an area that has been contaminated by BW or CW agents can not be estimated as precisely as stay time in an area that has been contaminated by RW agents. The reason is that BW and CW hazards can be substantially reduced by the wearing of protective clothing and masks. In general, stay time will be limited only by the ability of personnel to wear protective gear. When an area has been contaminated by CW agents, a careful observation for symptoms of the effects of these agents will enable personnel to determine when their protective clothing and masks are reaching the end of their safe lives.

4E2.06 NATURAL DECONTAMINATION

After an attack, relative hazards are determined and perimeters are established in the light of data that are obtained by ABC survey teams. In all instances, the passage of time works in favor of decontamination teams. The longer it is possible to wait, the greater will be the extent of natural decontamination.

Figure 4-16 shows that radiological decay takes place at a relatively precise rate. It should be noted that after the first few hours following an attack, the advantage that is gained by waiting for further decay is reduced.

BW and CW agents also decay naturally, although their rates of decay may not be predicted as precisely as the decay rates of radiological substances. The following factors affect the rate of decay of BW and CW agents:

(1) Persistence of agent,

(2) Temperature,

(3) Winds,

(4) Moisture, and

(5) Sunlight.

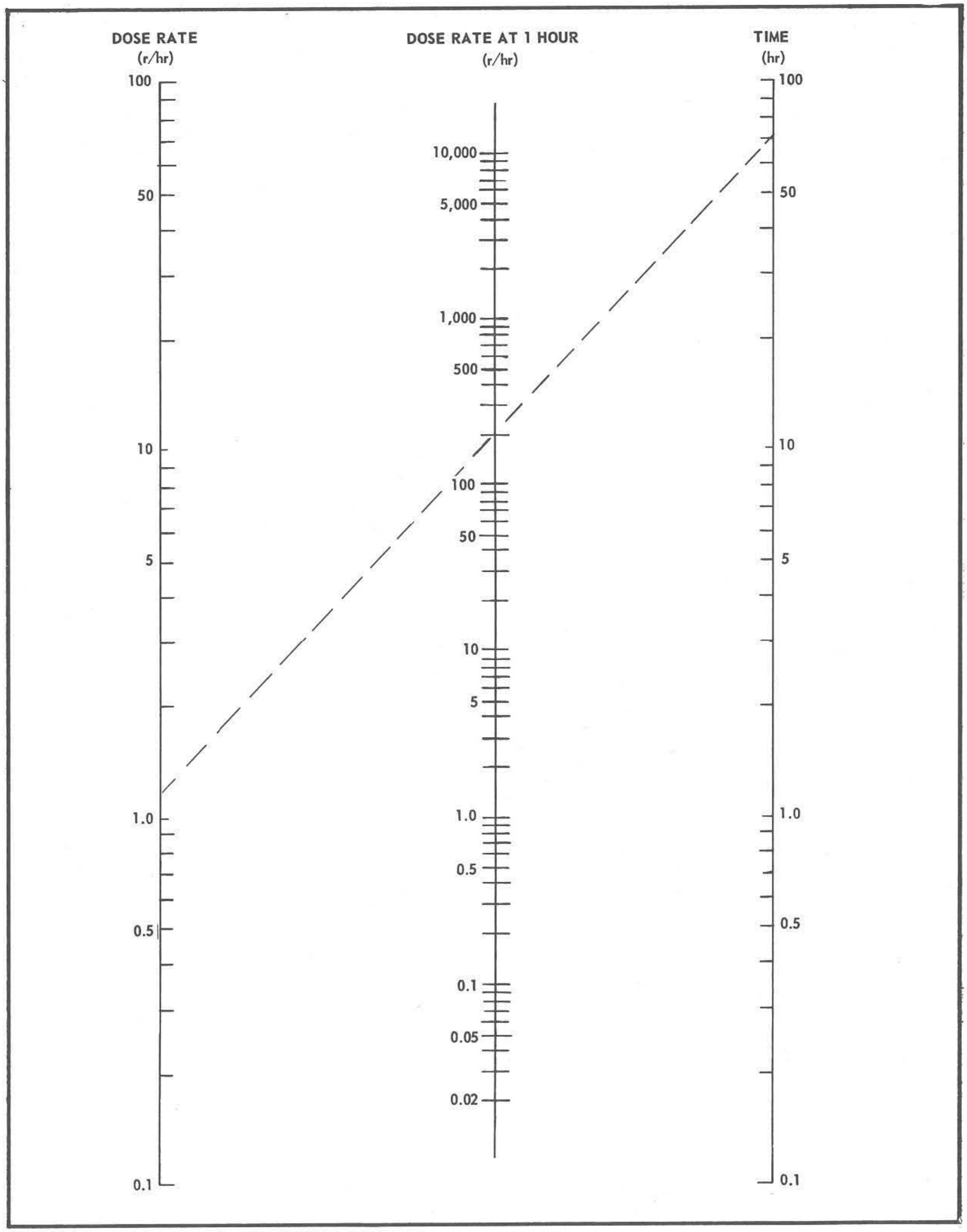


Figure 4-15. Nomograph for Determination of Relative Dose Rates From Residual (Fallout) Nuclear Radiation

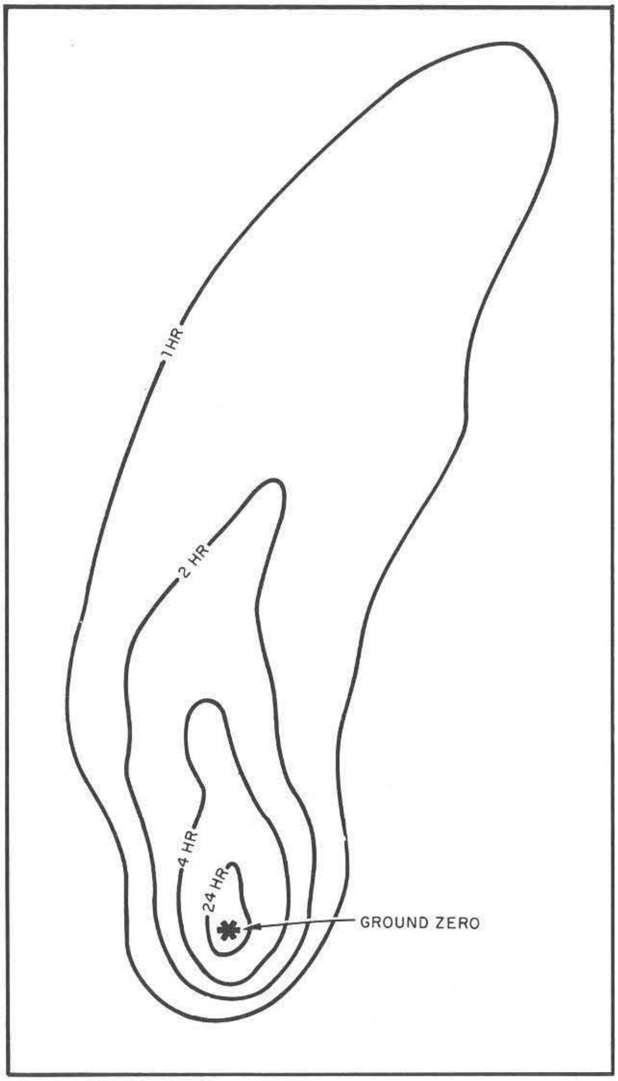


Figure 4-16. Shrinkage of a Contaminated Area For a Given Dose Rate

Section 3. SELECTION OF DECONTAMINATION MATERIALS AND EQUIPMENT

4E3.01 MATERIALS

Decontamination materials have been selected on a basis of applicability for as many ABC countermeasures as possible. For example, bleach is effective against several CW agents and against all known BW agents. Citric acid that is used in bleach solution is also useful in the removal of radiological contamination. Refer to paragraphs A50 through A60 of Appendix A for data on all special decontamination materials, including the packaging, uses, applications, effectiveness, and limitations thereof.

4E3.02 EQUIPMENT

Decontamination equipment has been selected because it can be used in a variety of decontamination procedures. Special items for ABC warfare decontamination are discussed in paragraphs A61 through A66 of Appendix A. Although not included in these paragraphs of Appendix A, many standard items of equipment that are available at most naval activities will not only be useful, but in some instances will be necessary in decontamination operations. Among these are bulldozers, fire hose, steam-cleaning rigs, laundry equipment, sprinkler trucks, brooms, and brushes.

4E4.01 RADIOLOGICAL AGENTS

Ordinarily, efforts to effect radiological decontamination of terrain are limited to vital access routes and localized areas that must be used by personnel. The methods that are employed in the decontamination of paved and unpaved areas are discussed below. (For details of these methods, see Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13, Revised.)

1. PAVED AREAS. After an area has been contaminated by RW agents, one of the first decontamination requirements is that access routes be cleared for the passage of work parties, the evacuation of casualties, and other requirements of an emergency nature. Access routes are likely to be littered with debris that is contaminated. The routes can best be cleared by the use of a crawler or a wheeled tractor with a bulldozer or angledozer attachment that can be used to push the debris into piles or windrows.

The further the contaminated material is moved from the access route, the less the subsequent radiation hazard. If water is available for firehosing, paved access routes should be hosed down, working from high to low points, and from noncontaminated to contaminated areas. Provision should be made in advance for the disposal of the runoff of the water that is used. This water must not be permitted to drain into an area where it will constitute a hazard. After access routes have been cleared and rough decontamination has been effected, relative freedom of the routes from residual radioactivity can be determined by monitoring.

2. UNPAVED AREAS. Radiological contamination on unpaved areas can best be dealt with either by removing or covering the contaminated soil. The following precautions must be observed regardless of the technique that is employed: (a) equipment operators must wear masks and remain on their equipment as much as possible while they are in contaminated areas, (b) before the soil is disturbed it should be wetted down to settle the dust, and (c) radioactive soil that is removed must be disposed of in a safe manner.

The various techniques that may be employed include the following.

(1) Blading. Blading is accomplished by a crawler or a wheeled tractor with an angledozer or bulldozer blade. The angledozer blade is preferred because it is more flexible and provides better directional control of the soil. The blade removes the top layer of contaminated soil and pushes it away from the scraped area. This technique can be used in scraping roadways or unpaved areas with firm cohesive soils. The removal rate varies from 2,000 to 12,000 sq ft per hour, depending on the size of the equipment and the nature of the soil and terrain.

(2) Grading. The use of a motor grader for soil removal involves the same principle of operation that is employed by the crawler or wheeled tractor with a dozer blade. The motor grader is more effective on roadways or long, narrow areas than it is on large, open areas. The removal rate is approximately 4,000 lineal feet per hour on a roadway that is 16 feet wide.

(3) Plowing. The military type of plow can be used as an attachment for, or can be drawn by, a tractor to turn contaminated soil over so that it will be covered with several inches of noncontaminated soil, which may reduce the dose rate as much as 85%. Plowing may be done in noncohesive and moderately cohesive soil that is relatively free from rocks, roots, and other obstructions. Plowing is not a preferred method of decontamination for well-traveled areas, because passage over the roughly plowed terrain will be difficult for pedestrians and vehicles unless the soil is subsequently rolled. The use of the plow should be confined to less traveled areas or to the creation of buffer zones around a working area that has been scraped or filled. The average plowing rate under normal operating conditions is 35,000 square feet per hour.

(4) Scraping. Contaminated soil can be removed by scraping with self-propelled or drawn-type equipment. In general, the technique that is used in the removal of soil with a scraper is the same as that used with a tractor dozer or a motor grader, but a more effective surface removal is achieved. Both cohesive and noncohesive materials can be removed by scraping. The outstanding advantage of the scraper is its range of operations. It can dig and haul in one pass, and if necessary carry the full load for miles. The rate of soil removal is approximately 5,000 sq ft per hour for an 8-cu-yd scraper, and up to 14,000 sq ft per hour for a 12-cu-yd scraper.

(5) Scraping and plowing. A greater depth of penetration, and consequently a greater reduction in contamination, can be achieved by first scraping away the top layer of soil and then plowing.

(6) Filling. Filling involves the placement and spreading of clean soil over contaminated soil. Availability of clean soil in the area will govern the feasibility of this method of decontamination. The use of scrapers is recommended for filling and scraping in one operation. In addition, scrapers can be used to transport clean soil over considerable distances.

The foregoing techniques are rapid and effective means for the decontamination of unpaved areas. The following data indicate the relative effectiveness of the various methods. When additional passes are required to further reduce residual numbers, they should be made at right angles to the previous passes.

Soil removal technique	Residual number after one pass
Filling (6-in. depth)	0.15
Grading, motor grader (2-4 in. cut)	0.07
Scraper, motorized (2-6 in. cut)	0.15
Plowing, (8-10 in. deep)	0.15
Grading, with 2-4 in. cut and plowing at 8-10 in. depth	0.02

3. AGING AND SEALING AS AN ALTERNATE TECHNIQUE. The use of the aging and sealing technique in radiological decontamination is relatively simple, and this method is suitable for large-scale operations on grounds, roads, taxiways, and runways.

Because alpha particles are an inhalation hazard and usually have a long half-life, sealing may be desirable when they are present. In general, alpha particles will be a problem only after an accident has occurred in which a weapon containing plutonium was involved (Appendix B). Under such circumstances, the general procedure is to wait until gamma activity is down to a relatively low level and then seal in the alpha contamination. Sealing could be accomplished before the gamma decay has taken place, but in so doing operating personnel would be subjected to greater hazards.

The most suitable material for this type of sealing is asphalt. A standard bituminous liquid distributor sprayer may be used for application of the asphalt to the surface. The amount of asphalt that is required will depend on the surface. Areas that are used for traffic, such as roads, runways, and taxiways, should be given coatings that are sufficiently thick to withstand the expected use. A lighter application will suffice for other areas.

4E4.02 BW AGENTS

Disinfection of extensive outdoor areas is not usually a practicable means of nullifying the effects of BW agents, nor would it be justified if the agents had relatively low viability and might be expected to succumb rapidly to sunlight, temperature changes, and other physical factors of environment. In fact, the time that would be required for the detection and identification of a particular BW agent might exceed the anticipated period of its viability. However, evidence in the literature indicates that this assumption is not always valid. For some unknown reason, microorganisms have the ability to survive on dust or on bedding for long periods of time. Blankets that contained streptococci were found to hold viable organisms after more than three months' storage. Tests on dust that was collected from hospitals, houses, schools, dormitories, and similar buildings gave positive results.

Land surfaces, streets, and sidewalks that have been contaminated by BW agents can often be ruled out of bounds to personnel and vehicles. The resulting cessation of traffic will considerably reduce secondary infectious aerosols, and the BW agents will lose their viability in time. It may not be possible, however, to restrict some areas, and solar radiation and aeration may decontaminate them only to a limited extent. In such instances, decontamination procedures and/or the use of suppressants may be necessary.

1. DECONTAMINATION. The two classes of materials that are most suitable for exterior BW contamination are those that (a) act by release of chlorine and (b) have a caustic action. Materials that are usually available include solutions of calcium hypochlorite (HTH), chloride of lime (bleach STB or Grade 3), sodium hypochlorite (ordinary household bleach), and sodium hydroxide (caustic soda or lye). Any solution that contains approximately 2 percent of available chlorine and 1/2 of 1 percent of an anionic detergent such as Nacconol or any other anionic detergent is effective on surfaces. Mixtures that contain more than 2 percent of available chlorine may be diluted to give the desired concentration. For details concerning the foregoing materials, see paragraphs A50 through A60 of Appendix A.

Mixes that are used for horizontal surfaces can be applied with any spray equipment of suitable capacity. For large areas, the appropriate equipment is the standard M3A2 or M6 400-gal decontaminating apparatus. For small areas, the standard CW 3-gal M1 decontaminating apparatus may be used.

The current model of the M1, however, is not designed for use with highly corrosive materials; therefore, to prevent serious damage, it must be thoroughly cleaned immediately after use.

A new compound that is under investigation for use in interior BW decontamination is currently being standardized. It is called beta-propiolactone. This chemical is suggested as a substitute for formaldehyde as a vapor phase disinfectant because it is (a) more active than formaldehyde and (b) considerably less persistent. Beta-propiolactone is not currently available but is mentioned to indicate the trend in research on this subject. This chemical is characterized by a slightly sweetish odor that is irritating, and it has lachrymatory properties even at low concentrations of the chemical vapor.

It now appears that beta-propiolactone, in the concentrations that are recommended for BW decontamination, will not corrode metals or have a deleterious effect on materials. Beta-propiolactone was successfully used at Fort Detrick to decontaminate (a) chambers with a volume that ranged up to 3,000 ft^3 and (b) buildings with a volume that ranged up to 75,000 ft^3. The temperature was maintained at 24° C, and the relative humidity was raised to 80 percent. Sixteen liters of beta-propiolactone were disseminated by a fogger into a building. An average of about 5 mg of beta-propiolactone per liter of air was maintained throughout the period of treatment. After a two-hour exposure to the disinfectant, no viable spores were recovered. The building was habitable after two days of normal aeration, that is, with doors and windows open. No damage to painted surfaces or metal fixtures in the building was noted.

Beta-propiolactone is not flammable in air concentrations that can theoretically exist under normal atmospheric conditions. Available information on toxicity is somewhat limited. Indications are that humans can detect odors at a concentration of 0.05 mg of lactone per liter of air. Because of the lachrymatory properties of beta-propiolactone, humans can not tolerate concentrations that are greater than 0.1 mg of lactone per liter of air for longer than 5 minutes. Undiluted beta-propiolactone produces no harmful effect on skin if it is washed off immediately; however, if it is held in contact with the skin for a period in excess of 1/2 hour, blisters are formed.

Preliminary data show that beta vapor, when employed under proper conditions, is approximately 25 times more active than formaldehyde.

The one big disadvantage of using beta-propiolactone is that it must be kept cold while it is in storage in order to obtain reasonably long shelf life. At 4° C it can be stored at least 3 years without appreciable change. However, at 54° C it undergoes polymerization within 6 to 8 weeks.

a. Application. An operating crew of four men is required for efficient use of the 400-gallon sprayer, while only one man (in addition to the mixing crew) is required for the 3-gallon unit. Because the 3-gallon unit is used to decontaminate relatively small articles and areas, no estimate of cycle time of filling and spraying is possible. For the 400-gallon apparatus, the time that is required for various operations is as follows.

Operation	Time (min)
Filling with water	10
Charging with bleach	20
Mixing	15
Spraying	20 (varies with rate of application)
Hauling	Varies with distance to water point

Table 4-4 shows the recommended mix and rate of application for the chlorine compounds. The mixture is sprayed at the rate that is indicated for the particular type of surface; and to assure complete decontamination, it is allowed to remain on the surface at least one hour. To provide complete wetting of the surface, a suitable powder or liquid detergent should be added to all solutions at the rate of 1/2 of 1 percent by weight. The effectiveness of the procedure may be greatly increased by a thorough scrubbing with either hand or power brooms.

Sodium hydroxide solution is a highly effective decontaminant for flat surfaces. Such solutions, however, are extremely hazardous, and personnel who use them should keep all parts of their bodies covered. A ten-percent solution (by weight) of lye and water, when sprayed on a surface, will almost completely sterilize the area within an hour. On sloping surfaces, however, this solution, as well as the chlorine solutions, tend to run off before decontamination is complete. No specific application rate is recommended for sodium hydroxide solution, except to thoroughly wet the surface. This usually means about 1/8 gal per sq yd on smooth concrete and 1/2 gal per sq yd on compacted earth. Mechanical agitation, such as brooming, will increase the coverage and improve the effectiveness of the procedure.

TABLE 4-4

Chlorine Compounds Used as BW Decontaminants

Decontaminant	Conventional use	Approximate available chlorine as packaged (%)	Recommended mix (parts of decontaminant to parts of water by weight)	Type of surface to be treated	Recommended rate of application (gal/sq yd)	Conventional packaging
Calcium hypochlorite (HTH)	Water purification	70	3/97	Horizontal concrete Horizontal packed earth	1/8 1/2	Powder; Navy stocks 6-oz cans 5-lb cans, 100-lb drums
Chloride of lime (bleach STB or Grade 3)[1]	Chemical warfare decontamination	30	7/93[2] 1,300 lb of bleach and 225 gal of water make 305 gal 40/60[3]	Horizontal concrete Horizontal packed earth Vertical concrete	1/8 1/2 1/8	Powder; Navy stocks 50-lb drums
Sodium hypochlorite (commercially available as household bleach)	Bleaching	5-10	Reduce to 2% available chlorine	Horizontal concrete	1/8	Liquid, Navy stocks 1-qt jars and 5-gal carboys. Commercially available in pint, quart, and gallon jars.

[1]Bleach that has been in storage for extended periods of time will lose some available chlorine. As a result, the concentration of the mix must be increased proportionately.

[2]Clear solution for BW only (Appendix A).

[3]Antiset M-1 (chemical warfare) should be added at the rate of 1/2 lb of antiset per 100 lb of bleach when the slurry is used in the 400-gal decontaminating apparatus. Antiset must be added to the water before the bleach.

b. Protection of Operating Crews. Because the decontamination process may dislodge pathogens from contaminated surfaces, operating crews should be equipped with masks, hoods, rubber gloves, rubber boots, and two layers of clothing. For additional protection against the decontaminant, other items of protective gear should be added or substituted as necessary. Persons who handle decontaminants should avoid getting the solutions on the skin, in the eyes, or in the mask canister. If the decontaminant does come in contact with the skin, it should be washed off with water immediately. Men who handle and mix decontaminants outside of contaminated areas should be equipped with goggles, rubber gloves, boots, and slickers.

Particular care should be exercised in handling lye, because both solid and liquid forms attack the skin, eyes, and clothing. Lye does not give off a poisonous vapor, but it is poisonous if swallowed; therefore, goggles, rain gear, rubber gloves, and boots should be used during all operations with this chemical. Spillage may be neutralized by a weak acid such as citric acid or acetic acid (vinegar). Heat is liberated when lye solutions are prepared, so containers should not be handled with the bare hands.

2. SUPPRESSANTS. The techniques that are used in the decontamination of unpaved surfaces (paragraph 4E4.01) have value in the suppression of pathogens.

In addition, the following suppressant techniques can be employed against pathogens.

(1) Water can be applied carefully and directly downward to prevent the formation of secondary aerosols; high-pressure spraying is not satisfactory. Tank trucks that are equipped with spray bars, a hose attached to a water hydrant, or a sprinkling cart can be used. Enough water should be applied to thoroughly wet the surface and vegetation. Water does not kill pathogens, but merely seals them to the surface; therefore, spraying must be repeated. This technique is not efficient in climates where drying is rapid.

(2) Fuel or lubricating oil can be used as a suppressant to prevent the formation of secondary aerosols for limited periods. Enough oil should be used to completely wet the surface, plus some for subsequent penetration. If the first treatment does not provide sufficient protection, it may be necessary to repeat the process within 24 hours after the first application has cured. Oil has a slightly more permanent effect than water, but even oil will be eventually drawn into the soil, leaving the surface dry. Salvaged crankcase oil, Navy Special, Bunker C, or diesel fuel oils can be used with bituminous distributors or tank trucks that are equipped with spray bars for treating large areas. The M1 sprayer apparatus can be used on small areas.

(3) Asphalt and tar are the most effective suppressants. In addition to their use as sealants, they can also be applied hot to kill many pathogens. They are especially effective for small, heavily contaminated areas.

(4) Burning vegetated areas also destroys many pathogens.

4E4.03 CW AGENTS

The hazards from CW agents on paved and unpaved surfaces may be controlled in part by establishing out-of-bounds areas and waiting for natural decay to occur. Persistent agents, however, may present a problem when they are present on access routes and localized areas that are used by personnel.

Decontamination of areas that have been subjected to CW agents involves the use of various materials, equipment, and techniques that are also involved in countermeasures against radiological and BW contaminants. Existing recommendations for procedures in CW decontamination of outdoor areas are detailed in Table 4-5.

Reference to Table 4-5 will show that bleach, dry-mix bleach, slurry, and DANC solution are approved for use on various outdoor surfaces. It is clear that impossibly large quantities of chemical decontaminants would be required for complete treatment of extensive areas. These materials are as follows.

(1) Dry Bleach. Dry bleach is spread by hand or by a dry-agent decontaminating apparatus; desirable coverage is about 1 lb per sq yd. This material is extremely corrosive to metals. A suitable dry mix consists of two parts of bleach and three parts of earth or sand. This mix may be spread on appropriate surfaces. In the dry form it may ignite when it is spread on liquid mustard agents. Dry bleach is not effective at temperatures that are below 20° F.

(2) Slurry. A slurry is a wet mix that can be applied with a broom, swab, or a 400-gal sprayer (paragraph A62 of Appendix A). When the slurry is to be applied with a swab or broom, equal weights of bleach and water are mixed. When the application is to be made with a power sprayer, four parts of bleach are mixed with six parts of water, and one-half pound of M1 antiset is added for each 100 lb of bleach. Antiset must be added and mixed in the water before addition of the bleach.

Bleach slurry should be used at the rate of 1 qt per sq yd on concrete and up to 1 gal per sq yd on tall grass.

The apparatus that are used in CW decontamination include the following special items, which are discussed in detail in Appendix A, as referenced.

1. DECONTAMINATING APPARATUS, M6 AND M3A3. The M6 and M3A3 decontaminating apparatus (paragraph A62 of Appendix A) are modified orchard sprayers that have been adapted to handle bleach slurry. Average coverage per filling for a smooth surface is 1,300 sq yd. Antiset is required in the slurry mixture, but the slurry should not be used even with winterized equipment if the temperature has dropped to 20° F. However, other chemicals, such as organic solvents, can be used at temperatures that are down to 0° F. When bleach slurry is being used at temperatures between 40° F and 20° F, the following procedure should be employed.

(1) Operate engine until temperature rises to 40° F.

TABLE 4-5

CW Decontamination of Outdoor Areas

Basic material	Area	Primary method	Secondary method	Field expedient	Remarks
Earth	Roads, bivouacs, pathways	Dry-mix bleach	Slurry	Plowing under, covering with earth, removing top layer of soil, weathering, fire	
Concrete	Roads	Dry-mix bleach or slurry	DANC solution	Covering with earth	Allow slurry to remain 24 hr, and reapply as necessary. Do not use DANC solution for G-gases.
Brick, stone	Roads	Dry-mix bleach	Slurry	Covering with earth	Allow slurry to remain 24 hr, and reapply as necessary
Asphalt	Roads	Dry-mix bleach	Slurry	Covering with earth	
Grass	Fields	Slurry	Fire	Covering with earth, removing top layer of soil, weathering	
Sand	Fields, beaches	Dry-mix bleach	Slurry	Covering with earth, removing top layer of soil, weathering, fire	Most chemical agents penetrate more than 2 in.
Tall grass, undergrowth	Meadows, jungles, forests	Slurry	Fire, exploding bleach drums	Weathering	Extensive areas should be decontaminated only if vital to mission

(2) Fill tank with hot water, add antiset, and mix two minutes; then add bleach.

(3) Circulate mixture between tank and pump to prevent freezing.

(4) Spray mixture continuously until tank is empty; otherwise, spray hose may freeze.

(5) When tank is empty, disconnect hose and place it where it will not freeze.

2. DECONTAMINATING APPARATUS, M1. The 3-gallon M1 decontaminating apparatus (paragraph A61 of Appendix A) is intended primarily for use with DANC solution, but it may also be employed to spray hot, soapy water or organic solvents. After each period of use, it should be drained and washed thoroughly to prevent corrosion and nozzle clogging.

One DANC solution unit fills the apparatus and is enough to decontaminate a truck or 50 sq yd of surface under average conditions. The M1 apparatus will function in extremely cold weather provided that it is not filled until immediately before use.

In addition to the countermeasures that depend on the use of chemical neutralizers, outdoor CW decontamination may be accomplished by plowing under the surface layer of earth, covering the surface with uncontaminated earth, or by burning over the surface, where applicable.

Section 5. DECONTAMINATION OF STRUCTURAL EXTERIORS

4E5.01 RADIOLOGICAL DECONTAMINATION

It should again be emphasized that radioactive decay proceeds rapidly in the early hours after a nuclear burst. Therefore, if the situation permits, the hazards to decontamination personnel can be reduced by delaying decontamination operations for a few hours until natural decay has reduced radioactivity to a safer level.

When active countermeasures are necessary, however, decontamination of building exteriors can be carried out by hosing the roofs and outer walls. In most instances the major portion of radiological contamination can be removed by such simple methods. Care should be exercised, however, that wash water containing contaminants is carried off by the storm sewers or otherwise diverted into safe channels for disposal.

4E5.02 BW AGENTS

Because exteriors of structures present vertical as well as horizontal surfaces, thin decontaminating solutions are not suitable because they will run off vertical or inclined surfaces before decontamination has been completed. A thick slurry is required on such surfaces so that the mixture will adhere. Bleach that is mixed with water in the proportion of 40 parts of decontaminant to 60 parts of water (by weight) forms a satisfactory slurry for walls. If sodium hypochlorite and similar solutions are employed, it may be desirable to form a slurry by the use of some inert material such as lime or diatomaceous earth.

When a slurry is to be sprayed on a vertical surface, a high-pressure device will be required to supply enough pressure so that the viscous material will reach the tops of the walls. The best equipment for this purpose is the 400-gal decontaminating apparatus that is described in paragraph A62 of Appendix A. The 3-gal decontaminating apparatus can be used on limited areas.

4E5.03 CW AGENTS

The decontamination of persistent CW agents on structural exteriors involves countermeasures that are similar to those employed in BW decontamination. The problem of decontaminating both horizontal and vertical surfaces also exists. Materials and devices that are recommended for CW decontamination of exterior surfaces are included in Table 4-6. From this table it can be seen that the principal countermeasures involve the use of bleach on horizontal surfaces and slurry on vertical or sloping surfaces.

DANC solution has special utility in the decontamination of glass surfaces and as an alternate spray to be used on concrete and wooden walls that are out-of-doors. DANC solution, however, is unsuitable for G-agent decontamination, and it should not be used indoors because of its toxicity.

TABLE 4-6 (1 of 2)

Decontamination of Persistent War Gas

Basic material	Area	Primary method	Secondary method	Field expedient	Remarks
Concrete	Walls, floors, pillboxes, gun emplacements	Slurry	DANC solution	Covering with earth	Allow slurry to remain 24 hr, and reapply as necessary
Brick, stone	Walls, floors	Dry-mix bleach	Slurry	Covering with earth	Same as concrete
Painted surfaces	Walls, floors, vehicles, equipment	DANC solution	Slurry, washing solvent	Blotting off surface and aerating	DANC will soften or remove paint. Slurry should remain 6-24 hr
Wood	Walls, floors, boxes, crates, apparatus	Slurry and aeration, or immerse in boiling water for 1/2 to 1 hr	DANC solution, but not for G-series gases	Fire, where applicable	Allow decontaminant to remain on surface to neutralize escaping vapors
Plaster and opaque plastics	Interiors, apparatus	Slurry	Aerating, washing, weathering	Weathering	Plastics vary, but usually can not be steamed
Asphalt	Roofing	Dry-mix bleach	Slurry	Covering with earth	
Glass	Windows	DANC solution	Washing and aerating	Blotting off surface	
Metal	Equipment, metal containers	Washing and aerating	DANC solution (except G-gases); then cleaning and oiling, solvents	Aeration	Bleach and slurry effective, but will severely corrode most metals
Canvas	Tents, apparatus, gear	Boil in water (with washing soda) for 1/2 to 1 hr	Slurry; then washing with DANC solution (except G-gases)	Aeration	
Cotton and wool	Clothing gear	Boil in water (with washing soda) for 1/2 to 1 hr	Laundering, dry cleaning	Protective ointment, aeration	Wool garments will shrink if boiled or washed

TABLE 4-6 (2 of 2)

Decontamination of Persistent War Gas

Basic material	Area	Primary method	Secondary method	Field expedient	Remarks
Imperme-able fabrics	Imperme-able clothing, gasproof curtains	Boil in water for 1/2 to 1 hr	Slurry, washing	Weathering	
Leather	Shoes, belts, gear	Immerse in water at 120° F for 4 hr	Aeration, DANC solution (except G-gases)	Blotting off surface	Decontamina-tion not always com-plete. Do not wear next to skin. Use neat's-foot oil or protec-tive dubbing
Trans-parent plastics	Eyepieces, airplane canopies, gear	Washing	Solvent	Blotting off surface	
Rubber: natural and synthetic	Tires, gloves, boots, hose, insulation	Boil in water 2-8 hr, depending upon contami-nation and future use	Slurry	Protective ointment	For gas masks, use protec-tive ointment outside and inside at once. Wash eyepieces with GI soap. If heavily contaminated, burn or bury

4E6.01 RADIOLOGICAL DECONTAMINATION

Radiological decontamination of structural interiors is effected by systematic vacuum sweeping and vacuum cleaning. Most standard vacuum equipment will not retain extremely fine particles, and for this reason, an inhalation hazard may result. Particles of the contaminant are small but can ordinarily be removed by mechanical means.

After countermeasures have been carried out, their relative effectiveness can be tested by monitoring. If unacceptable radiation levels persist, it may be desirable to wash floors with detergent solutions or employ abrasive treatment.

Ordinarily, most of the radiological contaminant comes to rest on horizontal rather than vertical surfaces. The horizontal surfaces should, therefore, receive special attention.

4E6.02 BW AGENTS

When BW decontamination is necessary for the structural interiors of shelters, warehouses, or similar structures, one of the most practical fumigants is formalin. Navy stock formalin is a solution of water, methanol, and 37-percent formaldehyde. For effective decontamination, the formalin vapor should remain in contact with the area for at least 8 hours at a relative humidity of at least 65 percent.

The building to be fumigated need not be sealed tight, but windows and doors must be closed, and large openings shut off from the outside. Drawers and cabinets within the structure should be opened. The decontaminant can be vaporized with fog generators (paragraph A64 of Appendix A) or by bubbling steam through an open container of the formalin solution. If steam is used, it must be led into the building through a hose, because formalin gas must not come in contact with an open flame. Another method is to use ordinary paint spray equipment that will develop 50 psi of pressure. The mixture and precautions to be followed and the details of application are described in paragraph 57 of Appendix A.

For disinfection of limited surfaces, swabbing with a mixture of one part of formalin stock solution and nine parts of water can be employed. Rubber gloves should be worn, because formalin is a strong skin irritant. It has a corrosive action on metals and may damage delicate instruments.

After formalin fumigation, cleanup operations must be undertaken and must include the use of forced ventilation and the heating of interiors for 48 hours before occupancy. Washing surfaces with hot water is the best method of removing formalin residues.

4E6.03 CW AGENTS

Contamination of structural interiors by CW agents is subject to the normal processes of decay, and especially so when the structures are opened to permit maximum ventilation. Under special circumstances, however, it may prove desirable to effect CW decontamination of interiors. In that event, available techniques will include the use of bleach and bleach slurry on various surfaces as indicated in Table 4-6 and the washing of surfaces with detergent solutions.

4E7.01 RADIOLOGICAL DECONTAMINATION

Radiological decontamination of equipment is ordinarily confined to items that are required for emergency recovery operations. Contaminated equipment that is not required for recovery operations should be segregated in an out-of-bounds area until natural decontamination has taken place.

Decontamination of vehicles, heavy weapons, and equipment of a similar nature can best be achieved by complete cleaning in the conventional way. The effectiveness of decontamination depends on the completeness of cleaning. Greasy metal surfaces can best be cleaned by the use of steam combined with a detergent.

4E7.02 BW AGENTS

BW decontamination of equipment is effected by the use of a gasproof space or chamber into which ethylene oxide-Freon gas (ETO-freon) is introduced. Data on ETO-Freon gas will be found in paragraph A55 of Appendix A. Steps to be taken in the decontamination procedure are as follows.

(1) Selection of Chamber. Initially, the chamber may be any space in a permanent or temporary building that is (a) reasonably tight and (b) large enough to permit entry of the equipment to be decontaminated. The chamber, however, should be as small as possible, considering the job to be done, and should have no air ducts, power panels, roof ventilators, or utility control valves that affect other parts of the building.

(2) Preliminary Steps. All cracks that are larger than 1/8 in. must be sealed with calking compound or adhesive tape. Vents, floor drains, and other openings must be fitted with wood, canvas, or metal covers.

(3) Gasproofing the Chamber. The chamber can be gasproofed by spraying the interior, including the walls and all doors except the access door, with a strippable plastic coating. Concrete floors need not be sprayed.

A paint spray apparatus with a nozzle that will spray a 6 to 8 in. band at 12 inches should be used. The coating should be applied as heavily as possible without causing excessive running. One pass builds up an average thickness of 0.01 inch, and passes should be repeated until the average thickness is 0.04 inch. About 16 gallons of coating per 100 sq ft are required to produce the requisite thickness. The coating will dry in 16 hours at 70° F. As an extra precaution, an additional coating can be sprayed over cracks.

(4) Installation of Piping. A 1-in. pipe inlet must be provided near the floor. The pipe must have an adapter so that it can be connected to the gas cylinder. A 2-in. outlet pipe must be installed close to the highest point in the chamber for the release of air as the ETO-Freon gas enters. The outlet pipe should be threaded for an ordinary pipe cap.

(5) Operation. When the interior of the chamber is dry, decontamination can be begun. The equipment should be arranged within the enclosure. The access door should be closed, sealed on the outside with tape, and sprayed with a coating of plastic film. Gas is then admitted to the chamber through the lower pipe, and when it begins to escape through the 2-in. outlet pipe, that pipe is capped. The desired amount of gas is introduced into the chamber. When the equipment is ready to be removed, the plastic film is stripped from the access door. The process should be repeated until all equipment is decontaminated.

(6) Precautions. Operating personnel must be masked and must wear protective clothing. Before any personnel enter after decontamination, the interior of the chamber must be aerated until the gas odor can no longer be detected. Items of decontaminated equipment must be aerated until they are free of gas odor; this precaution may require several hours for rubber or leather items.

4E7.03 CW AGENTS

Neutralization and removal of CW agents from equipment involves the use of bleach, bleach slurry, DANC solution, solvents, and washing and aerating, as specified for different types of surfaces in Table 4-6.

For example, emergency decontamination of a vehicle can be effected by spraying (3-gallon apparatus) or swabbing it with DANC solution. Gasoline from the tank of the vehicle can also be used to dissolve many war gases on metal surfaces. When circumstances permit, the vehicle can be decontaminated more effectively by the following procedure.

(1) The ground where the decontamination is to be effected should be covered with slurry or earth-bleach mixture.

(2) Dust and mud should be removed from the vehicle or equipment by scraping, and then the vehicle should be washed with soap and water. The contaminant will come off with the dirt.

(3) DANC solution should be used to spray areas that remain contaminated; then they should be scraped and repainted or oiled. If the contaminant is a G-series gas, an alkali, such as caustic soda, lime, or soda ash, should be used rather than DANC solution. GUNK, which is a mixture of alcohol, pine oil, naphtha, soap, and sulfonated castor oils, is useful in removing greasy, contaminated deposits. It can be used as a 10-percent mixture with water or as a 20-percent mixture with kerosene.

(4) The M1 apparatus should be used to spray tarpaulins with DANC solution.

(5) Contaminated wood surfaces should be treated with slurry, which is left on for 6 to 24 hours; the surfaces should then be washed down with soap and water.

(6) Little war gas will remain upon engine surfaces that become heated. Surfaces that remain relatively cool may be swabbed several times with gasoline.

(7) If standard decontamination materials and equipment are not available, repeated scrubbing with mud and hosing down will remove almost all war gases. Dry sand or earth will absorb considerable amounts of war gases. The use of these materials, followed by aeration and weathering, will eventually free equipment of contaminants.

(8) When decontamination is believed to be complete, tests should be conducted to confirm the fact. Lewisite (L), in particular, is likely to leave residual contamination.

For additional details concerning potentially useful decontaminants, see Table 4-7.

TABLE 4-7

Decontamination of War Gases

Rating	Mustard gases	Nitrogen mustard gases	Lewisite[1]	G-series nerve gases	Chloroaceto-phenone
Very good	Bleach DANC solution protective ointment HTH Chloro-amine-T Dichloro-amine-T		Bleach DANC solution protective ointment BAL Chloroamine-T Dichloro-amine-T	Caustic soda Caustic potash Lime Washing soda Slurry	Alcoholic caustic soda Alcoholic caustic potash Washing soda Aeration
Good	BAL Household bleach GUNK[2]	Bleach DANC solution Caustic soda Chloroamine-T Dichloroamine-T GUNK	Caustic soda Household bleach Soap Chlorine Lime GUNK	HTH Household bleach Ammonia Baking soda	
Fair	Chlorine Caustic soda Lime Washing soda Soap Organic solvents Aeration	Household bleach Lime Washing soda Soap Chlorine Sodium bisulfite Aeration	Washing soda Baking soda Organic solvents Aeration	Baking soda GUNK Soap and water Aeration	Organic solvents
Poor	Ammonia Baking soda	Baking soda Organic solvents Ammonia	Ammonia		

[1]The residue from decontaminated arsenical war gases is poisonous, but it can be neutralized by BAL or caustic soda solution.

[2]GUNK is a mixture of alcohol, pine oil, naphtha, soap, and sulfonated castor oil that is used as 10-percent mixture with water or 20-percent mixture with kerosene. GUNK is provided by the Air Force for decontamination of airplanes but may be used on other motorized equipment.

4E8.01 RADIOLOGICAL DECONTAMINATION

During an atomic attack, personnel may become contaminated with radioactive substances; they may also become contaminated after an attack while carrying out their duties as members of reconnaissance and survey groups or work parties. Contamination occurs largely in the form of fission products. These exist as small and sometimes hard-to-remove particles that come to rest upon the surface of the body, in the hair, under the nails, in folds of the skin, and in or on clothing. The sooner they are disposed of, the smaller the radiation dose that is received by the individual.

Personnel decontamination is, therefore, a vital factor in radiological defense. A suggested arrangement of a personnel decontamination station is shown in Figures 4-17 and 4-18. Personnel who use the station progress through rooms for undressing, showering, drying, monitoring, and dressing.

1. PERSONNEL DECONTAMINATION PROCEDURES. The following procedures should be used in personnel decontamination.

(1) In the undressing room contaminated clothing should be removed and placed in containers (G. I. trash cans).

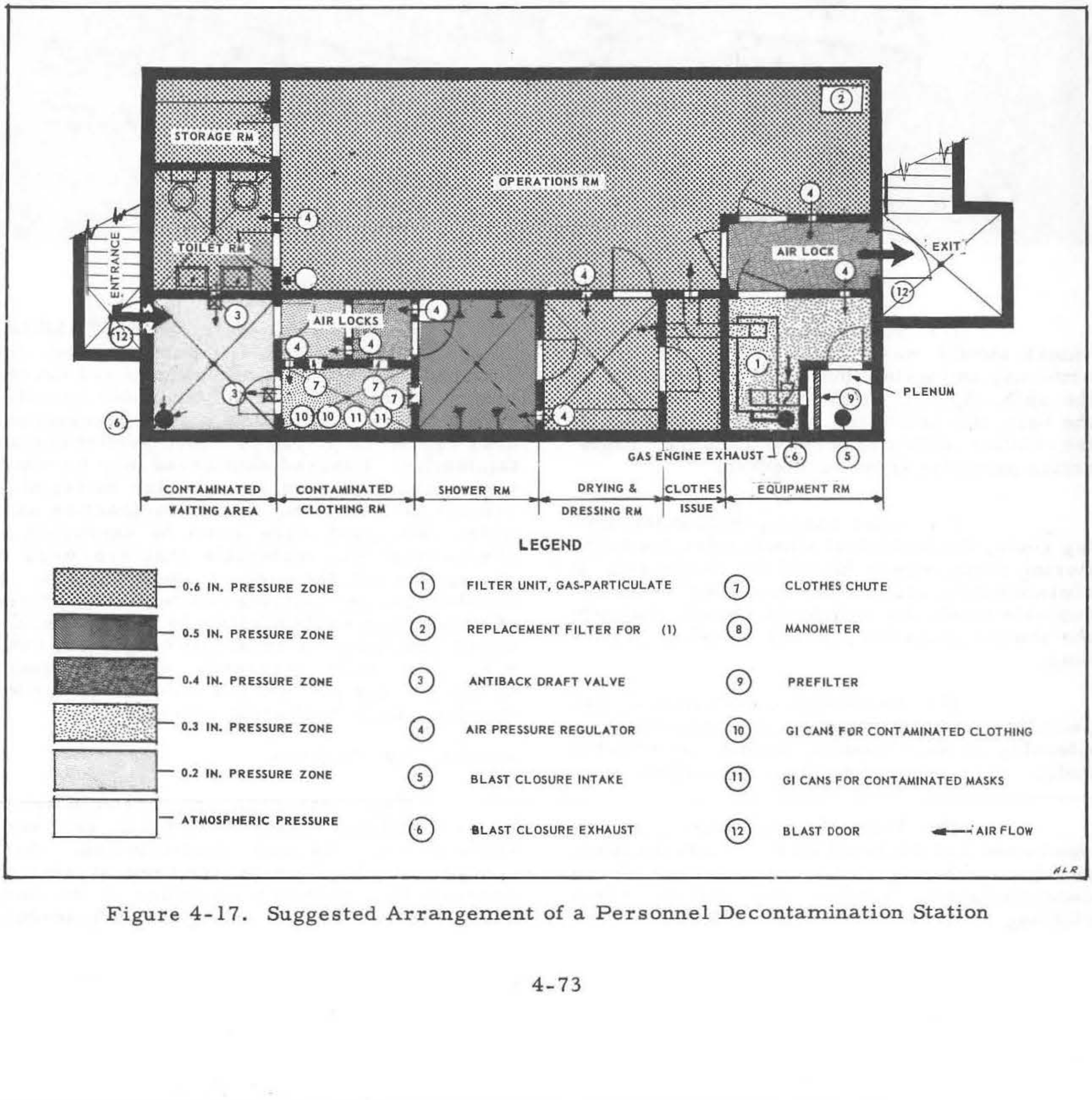


Figure 4-17. Suggested Arrangement of a Personnel Decontamination Station

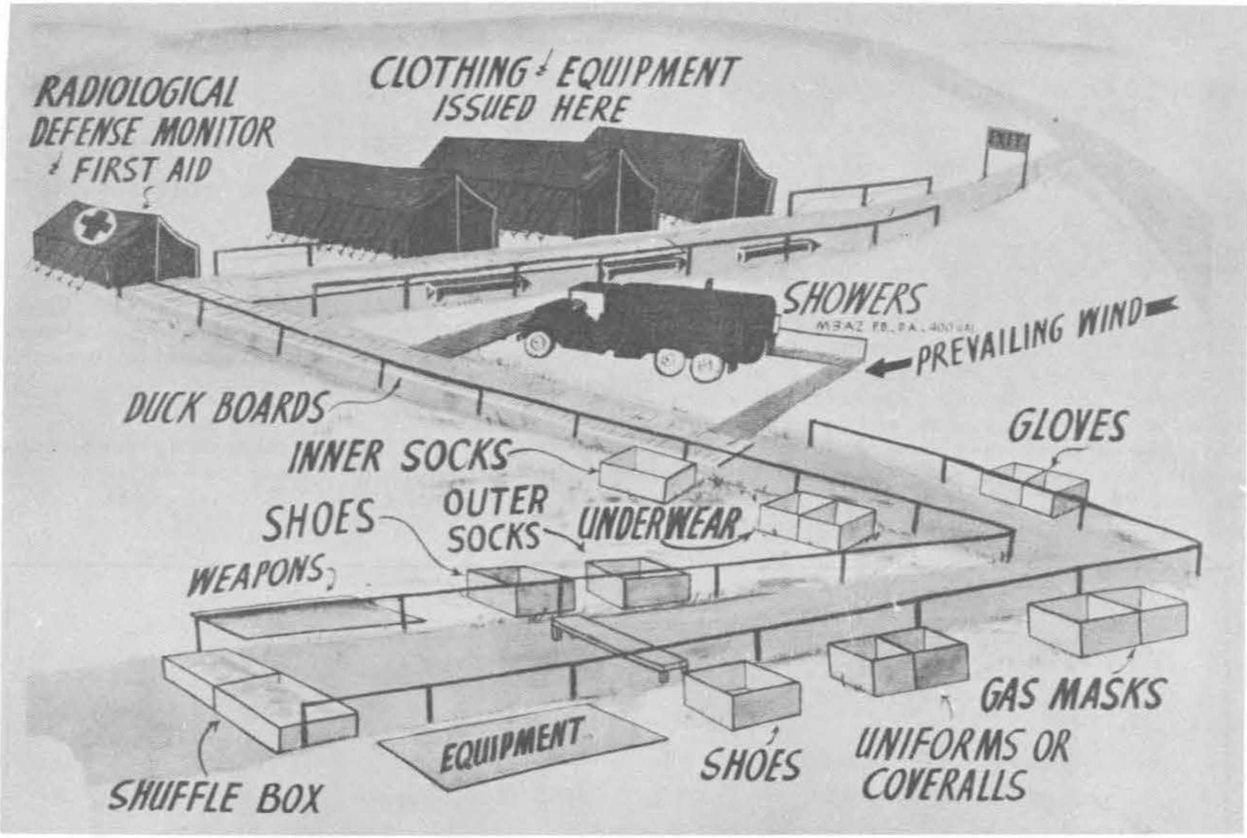


Figure 4-18. Improvised Personnel Decontamination Station

(2) In the shower room, the individual should wash down thoroughly, scrub with soap and water, but avoid any abrasion of the skin. Special attention should be given to the hair, the nails, and skin folds, because of the relative difficulty of removing small radioactive particles from such areas.

(3) After passing through the drying room, the individual should enter the monitoring room, where he will be monitored. If contamination has not been reduced to an acceptable level, the individual should return to the shower room for another round of scrubbing.

(4) Persistent contamination, especially in wounds, represents a special case. Cleaning of such wounds should be effected under supervision of medical personnel.

(5) When the individual has been monitored and declared free of contamination, he should proceed to the clean section of the decontamination station and receive clean clothing.

2. EMERGENCY DECONTAMINATION OF PERSONNEL. If personnel become contaminated with fission products and decontamination stations are not available or water supplies have failed, certain emergency measures can be employed to effect partial decontamination. Exposed skin areas may be wiped with clean fabric or any similar material to remove at least some of the radioactive particles, but great care must be exercised to assure that the materials that are used in wiping are not themselves contaminated. In similar fashion, clothing can be partially freed of radioactive contamination by vigorous shaking or brushing. It must be recognized, however, that such measures are emergency measures only and are not substitutes for the standard decontamination process.

4E8.02 BW AGENTS

When pathogens are disseminated in aerosol sprays, exposed clothing and body surfaces will become contaminated. Such contamination should be removed as soon as possible by a thorough scrubbing of the body with soap and water. The general procedure

and technique to be used is similar to that employed in radiological decontamination, with one exception. In lieu of the procedure that is outlined in item (2) of paragraph 1 of 4E8.01, a rubdown with 70-percent ethyl alcohol or 80-percent isopropyl alcohol is recommended if showers are not available. All parts of the body should be treated with the alcohol. The mask is then removed and placed in a covered G. I. can. Because no rapid means of detecting BW contamination is available, it will be necessary for personnel to be extremely thorough in the decontamination process.

4E8.03 CW AGENTS

Personnel who have been contaminated by CW agents should report to decontamination stations as soon as practicable. To forestall the injurious effects of contamination, they should dispose of their clothing, bathe thoroughly with water and soap or detergents as soon as possible, and receive clean clothing. The general procedure is the same as that employed in radiological decontamination (paragraph 4E8.01). Contaminated clothing and personal gear should be placed in closed metal cans for disposal or decontamination.

4E8.04 DECONTAMINATION OF CLOTHING

Special waterproof clothing should be hosed down while it is still worn by the individual. Ordinarily, this process will remove enough surface radioactive contamination to make the clothing suitable for reissue. This treatment will also reduce the BW and CW contamination, thus decreasing the hazards that will be incurred in later handling.

The disposition of ordinary clothing that has become contaminated depends on the degree of contamination and the facilities that are available. The following procedures shall be used in the disposition or treatment of ordinary clothing.

(1) Worn garments that are replacable and highly contaminated shall be destroyed.

(2) Potentially useful garments that are highly contaminated shall be retained so that radioactive decay can take place. Aging has a beneficial effect for both BW and CW agents that are not highly persistent.

(3) Potentially useful garments that exhibit a minor degree of initial contamination shall be laundered.

In general, the proper method for the decontamination of clothing depends on the type of attack to which the clothing has been exposed. Clothing that has been subjected to radioactive contamination should be laundered to remove as much of the radioactive material as possible. If the level of radioactivity of laundered clothing is still high, the clothing should be disposed of. Safe disposal of water that has been used in the laundering process must be assured.

Clothing that has been used as a protection against biological agents can be decontaminated best by the use of ethylene oxide-Freon gas in a gasproof chamber. If such a chamber is not available, ethylene oxide ampoules can be used in a gas bag (paragraph A27 of Appendix A). However, care must be exercised in using ethylene oxide because this gas is highly toxic. After decontamination, the clothing should be hung in the open air and should remain there as long as the odor of the gas can be detected. Clothing may also be decontaminated effectively by laundering it in a solution that contains 2 percent of chlorine and 1/2 percent of a wetting agent. Clothing that has been used as a protection against chemical agents can be decontaminated by (a) washing it to remove and/or hydrolyze the agent and (b) exposing it to bright sunlight to hasten the evaporation and decomposition of the agent.

4E9.01 APPROVAL FOR CONSUMPTION

Foods that are suspected of any contamination should be inspected and approved for consumption by the medical department.

4E9.02 RADIOLOGICAL DECONTAMINATION

When foods are in cans, bottles, or dustproof containers, contaminating particles on the outside are the only hazard. These particles can be removed by thorough washing, and the packages can be monitored to assure that the decontaminating process has been effective. Even unpackaged vegetables can be decontaminated in this manner, especially if washing is followed by peeling off the outer surfaces.

4E9.03 BW AGENTS

Foods in sealed containers are relatively secure against BW contamination, provided that the seals remain intact. Such foods, however, can be contaminated by saboteurs.

If only the exteriors of cans and bottles that contain foods have been contaminated, it is usually safe to use the contents, provided that the containers have been decontaminated before they are opened. This may be done by soaking the containers for 30 minutes in a solution of 2-percent available chlorine and 0.5-percent anionic detergent.

Unpackaged or bulk foods may be sterilized by heat application, provided that this is appropriate for the foods in question. Although heat penetration varies according to the type and bulk of foods, average processing may be accomplished by:

(1) Low-pressure cooking (5 lb/sq in) at 228°F for one hour,

(2) Oven cooking at 250°F to 300°F for 40 minutes,

(3) Boiling in water for 20 minutes, or

(4) Boiling liquids or foods that will melt under heat (for example, butter) for 15 minutes.

Foods that are packaged in cardboard or similar material should be decontaminated by (a) wiping the outer surfaces of the containers with a cloth that has been moistened with chlorine and detergent solution and (b) allowing the containers to dry for 30 minutes before they have been opened.

4E9.04 CW AGENTS

The disposition of foods that have been contaminated with CW agents is discussed briefly in paragraph 4E12.02. Food-testing kits are described in paragraph 4A5.06. Some additional considerations that are worthy of special emphasis are as follows.

(1) Well-packaged rations that are otherwise undamaged may frequently be salvaged by washing the contamination from their exteriors.

(2) Food that can not be reclaimed should be destroyed by burning or burying.

4E9.05 RECLAMATION OF FOODS CONTAMINATED BY CW AGENTS

Food supplies that have been contaminated by CW agents should be handled only by personnel who are (a) trained in decontamination methods and (b) equipped with proper protective clothing and masks. Before any decontamination procedure is undertaken, a careful survey should be made to determine the extent of contamination. From information that is gained on this survey, the exposed items should be divided into three groups for separate treatment as described below.

1. GROUP I. Group I will consist of packaged items that have been exposed only to the vapors of the agent. A consideration of the factors that are outlined above will serve as a basis for the evaluation of the seriousness of contamination. In general, it will be unsafe to issue items in this group to personnel until the items have been briefly aired to remove clinging vapors.

2. GROUP II. Group II will consist of packaged items, the outsides of which have been contaminated with the liquid agent. Attempts to decontaminate porous packaging materials, such as cardboard or wood, are likely to be unsuccessful and may actually result in the spreading of contamination. The best procedure in the handling of such items is to strip off the outer contaminated coverings and examine the inner layer to see if the agent has penetrated them. If it has, additional layers should be stripped off until an uncontaminated layer is reached. Items that are packed for military operations are usually packaged in boxes within boxes; such a procedure is

therefore feasible. When an inner uncontaminated package is reached, it should be placed in Group I. If the agent has penetrated to the food itself, it should be placed in Group III. When food supplies have been subjected to liquid contamination by the nerve gases, it is imperative that the outer contaminated coverings be decontaminated as soon as possible after stripping. The liquid nerve gases evaporate slowly from fiberboard and may present a vapor hazard to personnel for long periods of time. Canned goods can be decontaminated by any of the usual chemical methods such as the use of bleach slurry, soda ash, or noncorrosive decontaminating solution (DANC), followed by washing in water. Outer coverings that have been contaminated with nerve gases should be immersed in a solution of soda ash and water.

3. GROUP III. Group III will consist of unpackaged or poorly packaged items that have been exposed to a vapor or liquid agent. The general decontamination procedure to be followed in order is: (a) trimming of surface fat and grossly contaminated areas, (b) washing with water or a 2-percent sodium bicarbonate solution, and (c) boiling in water. Boiling in water may be eliminated when the contamination has been only with the vapors of lacrimators. When such an exposure has been light, aeration for a short time may be effective for decontamination. Frying, roasting, or broiling will not remove traces of vesicants from meats. In general, salvage of foods that have been heavily contaminated with droplets of the vesicants, especially the arsenical vesicants, is not practicable.

Further details concerning food decontamination may be found in Appendix III of Treatment of Chemical Warfare Casualties, NAVMED P-5041.

4E10.01 RADIOLOGICAL DECONTAMINATION

Conventional water treatment processes are a relatively inefficient means of removing those soluble radioactive isotopes that present the greatest hazard when ingested. Conversely, however, they do effectively remove the insoluble particulate matter. If further decontamination is required, the only processes that are worthy of serious consideration are ion-exchange and distillation. A mixed cation-anion exchange resin is needed. Such a column will remove 99 percent of the radionuclides that remain after normal water plant treatment. The usual mixed-bed demineralizers are available commercially; they are similar to those used in laboratories and are equipped with disposable cartridges that contain the ion-exchange resins. These demineralizers may be used to meet the emergency requirements if the level after normal treatment exceeds the energy limit. This limit is 9×10^{-2} microcuries per cu cm (3×10^{3} disintegrations per sec per cu cm) when the consumption period is 10 days, and 3×10^{-2} microcuries per cu cm (1×10^{3} disintegrations per sec per cu cm) when the consumption period is 30 days. Distillation is effective in the removal of radioactivity from water, but it is limited by the relatively low capacity of units that are available through the Shore Establishment.

4E10.02 BW AGENTS

Chlorine treatment with an adjustment of pH value (6.0 to 7.0) is most effective for the decontamination of water that contains BW agents. Water supplies that have been contaminated by BW agents may be made potable in a number of ways, including the following countermeasures.

1. RAPID SAND FILTRATION. Rapid sand filtration is a conventional treatment, but more chlorine is required than in the routine process. The water is prechlorinated to effect a free available chlorine residual of about 0.6 ppm after a contact period of 15 minutes or more. It is postchlorinated to produce a free available residual after 30 minutes to 5 ppm as the water leaves the plant and 1 ppm in the most distant part of the distribution system. The normal rate of flow through the sand filters should be cut in half if possible.

2. SLOW SAND FILTRATION. When the slow sand filtration method is used, prechlorination should be employed to the fullest extent short of effecting a residual. Rate of flow through the filters should remain standard. The postchlorination procedure is the same as in rapid sand filtration, but if the presence of botulinum toxin is suspected, the postchlorination contact period should be increased from 30 minutes to one hour.

3. IMPROVISED METHODS. The use of improvised methods is recommended when regular water treatment facilities are not available. Some of these are listed below:

(1) Boiling for 20 minutes,

(2) Distillation, if equipment is available, and

(3) Improvised chlorination to effect a free available chlorine residual of 5 ppm after 30 minutes (60 minutes if the presence of botulinum toxin is suspected).

4. FIELD TREATMENT. Iodine tablets can be used to sterilize water in small containers such as canteens. Three iodine tablets should be added to a quart of water; if a strong iodine odor is still present after 10 minutes, it is best to wait another 20 minutes before drinking the water. If the iodine odor is weak or absent after 10 minutes, the water should be discarded and 4 or 5 tablets should be tried in the next batch. Boiling for 30 minutes in addition to the iodine treatment is recommended if conditions permit.

5. CHLOR-DECHLOR PROCESS. The chlor-dechlor process is a highly effective variation of normal purification procedures, but because of the long contact period that is involved, it is not operationally possible in some plants. Chlorination is effected so that a free available residual of 15 ppm is present after the 2-hour contact period. Then a dechlorinating agent is employed to lower the residual to 0.5 ppm and make the water palatable.

The chlorine residual may be lowered by employing one of the following methods.

(1) Sulfur dioxide gas can be introduced into the water by a sulfonator, which is similar to a vacuum-solution-feed chlorinator except for the metering component. The sulfonator is best adapted to the dechlorination of large flows of water such as those of a regular treatment plant. In an emergency, a chlorinator could be used as a sulfonator.

(2) Sodium bisulfite or sodium meta-bisulfite can be introduced either by a dry-feed-solution device or directly, as in the batch-method employment. Solutions that contain these substances can also be fed with standard chlorinators.

(3) Sodium thiosulfate (hypo) can be used but it is not recommended because of the cost factor. The amount that is required can be established by a trial-and-error process, using orthotolidine solution to determine the desired residual.

The approximate theoretical amount of various agents that are required to dechlorinate 1 ppm of chlorine is as follows.

Agent	Amount (ppm)
Sulfur dioxide	1
Sodium bisulfite	2
Sodium meta-bisulfite	1.3
Sodium thiosulfate	7

4E10.03 CW AGENTS

When positive tests result from the use of the water testing and screening kit (paragraph 4A5.05), the water is considered to be contaminated. Tests must be made when residual chlorine is near zero. If supplies are found to be contaminated and no uncontaminated supplies can be obtained, decontamination on a large scale may prove to be desirable provided intact treatment plants and trained water-purification personnel are available. Under such circumstances, the intake pump that is used to withdraw water from the source should be placed at an intermediate level, so that only a minimum disturbance will occur in surface and bottom waters. The methods of treatment employed for relatively large volumes of water that have been contaminated by various agents and the permissible standards therefor are outlined in Appendix C. For emergency decontamination of small volumes of water, the following treatment, which involves the use of two Lyster bags, is recommended.

(1) Depending upon the agent that is present, dosages of activated carbon or soda ash as prescribed in Appendix C should be added to water in one Lyster bag. If identities and concentrations of contaminants are unknown, 2 lb of activated carbon and 2 oz of soda ash should be added.

(2) A wooden paddle should be used to stir the mixture for 20 minutes.

(3) An ounce or more of alum should be dissolved in a small amount of water, and this solution should be added to the water in the Lyster bag to effect coagulation.

(4) After thorough but gentle stirring, the mixture should be allowed to coagulate and clarify by sedimentation for 30 minutes.

(5) The supernatant water should then be siphoned to another Lyster bag, preferably through a filter.

(6) The water is now ready for test, and if it meets the standards that are set forth in Appendix C, it is ready for chlorination or iodination.

For information on the monitoring of CW agents by means of fish, refer to Appendix F.

Section 11. DECONTAMINATION OF STORES AND SUPPLIES

4E11.01 RADIOLOGICAL DECONTAMINATION

Because of the variety of materials and surfaces that are present in stores and supplies, many decontamination problems are encountered. If the immediate use of stores and supplies is not required, it is desirable to segregate them and allow the natural decay process to take place.

When the immediate use of stores and supplies is anticipated, securely packaged items present a minor decontamination problem. For example, radiological contamination is limited to external surfaces, and decontamination is largely a matter of vacuum cleaning and/or washing down the packages.

Stores and supplies that are not packaged at the time of attack may present a more difficult problem. In some instances, rough decontamination by washing down may be effected. In other instances, the use of water and steam combined with a detergent may be effective in removing more closely held particles from surfaces that can stand this type of treatment. The effectiveness of any procedure that is employed may be checked by monitoring. Perishable items should usually be destroyed without effort of salvage.

4E11.02 BW AGENTS

For many potential BW agents, natural loss of viability can be anticipated within a relatively short period of time. Stores and supplies that are not immediately required may therefore be segregated temporarily.

Stores and supplies that are in sealed containers will have the contamination on their exteriors. Some containers can be decontaminated by swabbing them with a chlorine and detergent solution and then aerating them. Other items, packaged or unpackaged, can be decontaminated by immersing them in (a) boiling water for 20 minutes or (b) a solution of 2-percent available chlorine and 0.5-percent anionic detergent.

When necessary, stores and supplies except food can be decontaminated by the ETO-Freon process that is described in paragraph 4E7.02.

4E11.03 CW AGENTS

Natural decay will solve the problem of CW contamination if sufficient time can be allowed. Packaged items constitute a smaller decontamination problem than unpackaged items, provided the contaminating agent has not been absorbed through the packaging.

When decontamination must be employed, the techniques that are described in paragraph 4E7.03 are applicable. Attention is also directed to Table 4-6, which outlines the processes that are appropriate for use on various surfaces.

4E12.01 RADIOLOGICAL DECONTAMINATION

After a nuclear attack, various items of equipment and material are likely to be in one of the following categories.

(1) Equipment or material that is so contaminated and so badly damaged by blast or thermal effects that repair efforts are not worthwhile.

(2) Porous materials that can not be decontaminated successfully.

(3) Contaminated equipment that is so delicate it can not be recovered by employing normal decontamination or sealing procedures.

Equipment and materials in the foregoing categories present no immediate problem if the area in which they are located is not to be occupied after an attack. If the material and/or equipment can not be left in its area of location, it must be collected and stored in an area that is not occupied by personnel.

In the accomplishment of this objective, the amount of handling that will be required should be reduced to a minimum and the spreading of radioactive dust should be avoided. It may be possible to destroy combustible materials by a controlled burning process. Here again, the amount of handling by personnel is likely to be a critical factor, and radioactive smoke and ash must not be permitted to blow into occupied areas.

Final disposition of radioactive wastes can be accomplished in three ways.

1. BURIAL ON LAND. Burial on land can be employed when entombment on land or burial at sea are not practicable. For permanent disposal, an underground cell that is lined with concrete and waterproofed with grout is recommended to prevent subsequent seepage. Care should be exercised in the selection of a burial site so that nearby sources of water will not become contaminated. The cell should be filled with the contaminated material and then covered with at least six feet of earth. Its position should be marked above ground and permanently recorded.

2. ENTOMBMENT. Entombment is a simplified type of land burial in caves or abandoned mines. After the contaminated materials have been put into place, the entrances to the caves or mines must be sealed, and the locations must be marked and recorded as in procedure 1.

3. BURIAL AT SEA. When contaminated materials are to be buried at sea, they should be sealed in drums or caissons that are strong and reasonably leakproof. The drums should then be dropped into deep water where no strong currents occur. The peacetime requirements for the disposal of radioactive wastes are covered in Radioactive-Waste Disposal in the Ocean, Handbook 58, National Bureau of Standards. Insofar as practicable, the same requirements should apply after a nuclear attack.

4E12.02 BW AND CW AGENTS

When BW and CW agents are the only sources of contamination, most contaminated items of equipment and supply will be subject to ultimate reclamation.

PART F. FACILITIES FOR DECONTAMINATION AND RECOVERY

Section 1. DECONTAMINATION FACILITIES

4F1.01 DESIGN OF A DECONTAMINATION CENTER

To serve as a base of operations for recovery teams, a decontamination center should be a gasproof and windowless structure that is located so it will be easily accessible to personnel. Such a facility will constitute (a) a place where personnel can eat and rest, (b) a control point for teams, and (c) a reissue station for clothing and equipment. Provision should also be made for the establishment of emergency decontamination stations in the event that the decontamination center is rendered inoperative. The plan of a decontamination center for recovery team personnel is shown in Figure 4-17. Its basic components consist of an unclean area, a washing area, and a clean area.

Pressurization of the various rooms and areas of the decontamination center should be as follows:

Area	Pressurization (in. of water)
Outer dressing and equipment room	0
Contaminated clothing room	0.3
Air locks	0.4
Inner dressing and washing area	0.5
Clean area	0.6

The unclean area includes an outer undressing room, contaminated clothing room, inner undressing room, and shower room. The shower room has drains that assure rapid removal of contaminated water.

The clean area for drying, monitoring, and dressing also provides for the storage and issue of clean clothing and protective gear, including masks. Masks must be ready for issue if the area outside the decontamination center is still contaminated. The clean area also includes space for toilet facilities, storage of decontamination team equipment, sleeping quarters for the decontamination team, and food storage and issue. Air locks must be provided at the entrance to the inside undressing area and at the exit of the clean area. A special equipment room should be provided to house the collective protector, space heaters, and water heaters.

4F1.02 IMPROVISED PERSONNEL DECONTAMINATION STATIONS

Improvised personnel decontamination stations can be set up in the field, and they will require only a small quantity of special equipment. The plan for such a station is shown in Figure 4-18. A lane approximately 6 ft wide is laid out along the course that personnel will follow through the decontamination station. Posts should be driven into the ground and ropes strung between them to mark the boundaries of the lane. The first portion of the lane is the unclean area, which is to be used for undressing. GI cans, open packing crates, or boxes should be placed outside the ropes for disposal of contaminated equipment and clothing.

After undressing, personnel should proceed along the lane to the washing area, where a truck-mounted water tank is located. Here the personnel should wash down and dry. The remainder of the lane is the clean area. Duckboards are laid in the clean area to prevent recontamination from the ground. Tents should be erected along this portion of the lane for the storage and issue of clean clothing and equipment. Benches should be provided for use in dressing. Any power-driven decontaminating apparatus can be used as the shower unit.

4F1.03 STORAGE FACILITIES FOR CONTAMINATED MATERIAL AND EQUIPMENT

Storage facilities for contaminated material and equipment should be provided in a remote part of the shore station where it will not be a hazard to personnel. In general, the area that is selected should be an open one

on the leeward side of the shore station. The area should be devoid of trees so that the full effects of the weather can be utilized for natural decontamination of BW and CW agents.

All materials and equipment that are not adversely affected by the weather should be stored in the open. Such items include automotive and construction equipment, lumber, oils and paint in drums, and construction materials.

Contaminated material that requires protection from moisture can be covered with tarpaulins or stored in an isolated building or shed. Complete covering of contaminated material, however, will delay natural decay of BW and CW agents, although it will have no effect upon the natural decay of RW agents.

4F2.01 FIREFIGHTING EQUIPMENT

Firefighting equipment that is used for recovery consists of the usual equipment of this type that is found on most naval stations. Such equipment, however, should be outfitted with communication and radiac sets. In addition, it will be necessary to implement with improvised equipment to the maximum extent possible. In the event of an attack, most activities will require more firefighting equipment than is usually assigned. For this reason, joint agreements for mutual support should be arranged with other fire departments in advance so that all will have ready access to equipment when it is needed. Decontaminating apparatus of all types can be adapted as firefighting equipment by simply adding firefighting guns of appropriate types and capacities. The capability of firefighting equipment may be limited by the availability of water supplies rather than the quantity of equipment.

4F2.02 DECENTRALIZATION AND DISPERSAL

When conditions warrant, it may be desirable to have two or more fire houses on the station to lessen the possibility of complete immobilization of the fire department. Such added installations, however, may be too expensive. As a minimum requirement, emergency facilities should be provided to house or contain trailer-mounted pumpers, extinguishers, and other portable firefighting equipment and tools. These emergency firefighting posts should be established at various locations on the perimeter of the station and at other locations on the station where the risk of fire is great. In any event, when a warning is sounded, firefighting equipment should be relocated at various predetermined dispersal points on the station.

4F2.03 FIREBREAKS

Firebreaks are open places such as streets, parks, bodies of water, cleared land, and specially designated areas that are intended to limit or stop the spread of mass fires. They are most important in an AW attack because of the size of fires that may occur. As a controlling measure against the effects of an AW attack, the accepted peacetime criteria for the spacing of new construction should be doubled.

Firebreaks should be kept clear of timber, brush, and any other combustible material. They should not be employed as vehicle parking lots, open storage areas, or for any other purpose that would prevent their immediate use as firebreaks. They may be employed, however, as drill grounds and recreational or sports areas.

Section 3. CLEARING AND REPAIR EQUIPMENT

4F3.01 GENERAL TYPES

The following paragraphs give the general types of equipment that should be used for demolition, earthmoving, materials-handling, transportation, and repair. This functional listing does not follow precise definitions as to category. For example, earthmoving equipment can also be used for demolition work. Also, no attempt has been made to list the sizes and capacities of the various items of equipment. Details on sizes and the proper application of construction and weight-handling equipment can be found in Part H of Administration and Operation of Transportation Equipment, NAVDOCKS TP-TR-1 (Revised July 1957).

The amount of equipment that will be required will depend on the local situation and will probably exceed the amount on hand. However, purchase of additional equipment for this purpose is not contemplated. Joint agreements that involve mutual support should be arranged to provide for the availability of equipment in time of need. The use of contractors' equipment in the vicinity is a possibility that should be investigated.

4F3.02 DEMOLITION EQUIPMENT

The demolition equipment that is listed below should be used primarily for removal of hazards such as collapsed structures, structures that are in imminent danger of collapse, piled equipment wreckage, and other obstacles.

(1) Cranes (truck, wheel, or crawler-mounted), with such working tools as skull crackers, hooks, orange-peel buckets, slings, and similar items.

(2) Crawler and wheeled tractors with angledozer or bulldozer attachments.

(3) Air compressors (engine-driven), with such working tools as hammers, drills, drivers, and breakers.

(4) Acetylene-burning equipment.

(5) Winches.

(6) Chain saws.

(7) Pulley block sets.

(8) Explosives and related items.

(9) Wire cable.

4F3.03 EARTHMOVING EQUIPMENT

The following essential earthmoving equipment and material is used primarily in clearing obstructions and hazards.

(1) Shovels (crawler-mounted).

(2) Cranes (crawler or truck-mounted) with clamshell or dragline attachments. The dragline has the greatest reach of any type of earthmoving equipment. This consideration may be most important when access is a problem.

(3) Crawler and wheeled tractors with angledozer of bulldozer attachments.

(4) Road graders.

(5) Carryall scrapers. Carryall scrapers have the greatest working range of any digging and hauling equipment.

(6) Bucket loaders.

(7) Ditchers and trenchers.

(8) Back hoes. Back hoes are the most powerful and accurate tools for excavation work when a great width of cut is not important.

(9) Explosives and related items.

4F3.04 MATERIALS-HANDLING EQUIPMENT

Essential equipment for handling materials in clearing and repair work is as follows.

(1) Cranes (truck or crawler-mounted), with slings, platforms, buckets, and similar working tools.

(2) Fork-lift trucks.

(3) Side-loader trucks.

(4) Straddle-carry trucks.

(5) Skip loaders.

4F3.05 REPAIR EQUIPMENT

Essential repair equipment that is used in clearing and repair operations includes the following.

(1) Arc welders (engine-driven).

(2) Acetylene welders and cutters.

(3) Air compressors (engine-driven).

(4) Electric generators (engine-driven).

(5) Machine shop trucks or trailers.

(6) Pumps (diaphragm, rotary, and centrifugal).

(7) Telephone and powerline construction or maintenance trucks.

(8) Miscellaneous hand and power tools.

4F3.06 AUTOMOTIVE VEHICLES

Automotive vehicles that are required for clearing and repair work are listed below. Passenger-carrying vehicles are not work vehicles and are therefore not included in this list.

(1) Dump trucks.

(2) Pick-up trucks.

(3) Low-bed trailers.

(4) Tank trucks.

CHAPTER 5. PLANS AND OPERATIONS

PART A. READINESS PLANNING

Section 1. CONCEPT

5A1.01 IMPORTANCE OF PLANNING

ABC warfare defense involves measures that are taken to prepare for, and minimize the effects of, atomic, biological, and chemical attacks. Insofar as Navy shore stations are concerned, the primary objective is to (a) maintain their operational status to the greatest degree possible in the face of an attack or disaster and (b) assure the accomplishment of their mission at all times.

The effectiveness of ABC warfare defense depends to a great extent on the planning, construction, and training that are carried on before actual attack. Planning must include provisions for early warning and intelligence, mutual aid, mobile support, and fixed support, and it requires effective liaison with other commands and agencies. Planning must provide for dispersal of installations, equipment, and personnel, both in space and in time. It must embrace strong elements of security against observation, espionage, sabotage, annoyance, and surprise; at the same time it must attain a condition of physical security that will assure a state of inviolability from hostile acts or influences. Planning must give careful attention to new protective construction or the alteration of existing construction, and it must provide special facilities such as control centers, decontamination centers, and emergency recovery stations. It must provide a basic indoctrination training program for all personnel, both military and civilian. Planning must include a continuous program for the training and retraining of personnel who make up the various elements and teams upon which recovery depends. It must provide for the availability of the various special materials and equipment that will be required for ABC warfare defense.

Effective planning and preparation, including training, is the very essence of ABC warfare defense. It serves to minimize losses under attack and facilitates rapid return to full operational efficiency.

5A1.02 PHASES IN PLANNING

OPNAV INSTRUCTION 3440.6 sets forth in detail the following five phases that must be planned for in passive defense:

(1) Long-range development measures,

(2) Normal peacetime fire protection and security measures of a continuing nature,

(3) Measures that must be effected upon receipt of a warning,

(4) Immediate post-attack or emergency recovery measures to save lives and minimize progressive or secondary damage, and

(5) Operational recovery measures.

5A1.03 PROBLEMS OF COORDINATED PLANNING

The broad potential effects of an ABC attack have made coordination of planning a factor of first-rank importance. Extensive areas are likely to be affected by an ABC attack--areas that include establishments of various branches of the Armed Forces, industrial installations, and elements of the civilian population. Effective mutual aid will depend on the degree of planning and coordination that have been achieved among the various military and civilian agencies. This is top-level planning, but the need for coordination extends down the chain of command to the smallest and most isolated activity.

An ABC attack could result in the temporary paralysis of extensive areas. In such an event, the problem of debris might create extremely serious, although temporary, transportation difficulties at a time when food and clothing, emergency hospitalization, materials for repair and reconstruction, and other essential supplies were urgently needed. In addition, contamination from radiological

fallout might prevent transportation facilities from operating in or through certain areas.

The aforementioned considerations emphasize the need for logistic planning as a part of overall planning for defense. The equipment and materials that are necessary for the accomplishment of missions of the various elements and their component teams must be provided in realistic quantities. Moreover, provision must be made for adequate stock levels, dispersal, and safe stowage of such materials.

5A1.04 CALCULATED RISK

Large-scale ABC warfare attack, like any other form of enemy action, is certain to necessitate the taking of certain calculated risks. Moreover, strategic and tactical situations frequently demand the assumption of such risks, although every effort must be made to avoid them.

The decision to assume a calculated risk is a command decision that may be made at various levels. Thus, the commanding officer of a naval activity, faced with the necessity of providing for emergency rescue after an attack, may be called upon to decide whether an engineering rescue team should be sent into an area that is known to be contaminated. Fundamentally, this decision differs in no way from the decision to order a vessel to press home an attack even though it is outgunned.

5A1.05 CHARACTERISTICS OF A NAVAL SHORE ACTIVITY

Characteristics of a naval activity with respect to geographical location, terrain, size, importance, relative permanence, and mission all have some bearing on defense planning. The following paragraphs contain a general analysis of these factors and their effects.

1. GEOGRAPHICAL LOCATION AND IMPORTANCE. With the advent of intercontinental bombers and long-range missiles, advantages that were formerly derived from geographical isolation have diminished appreciably. Whether or not a proposed target is worth the military effort that will be required to destroy it is likely to be a more important factor of consideration. Thus, a relatively small shore station that is situated in a critical target area might be more likely to suffer attack than a large isolated naval activity although the small station might not be the primary objective of such an attack.

2. TYPE OF CONSTRUCTION. The type of construction that is used at naval activities will influence readiness planning. Buildings at many activities were constructed before ABC warfare was known. In such instances, planning for defense will be concerned with the effective adaptation and modification of existing structures to meet modern needs. A newly constructed shore station, planned for long-time use, may have protective construction incorporated in the design.

Section 2. ESTABLISHMENT OF CENTRAL CONTROL

5A2.01 IMPLEMENTATION BY DISTRICTS AND BUREAUS

The establishment of a functional central control is essential to the operational efficiency of a coordinated defense plan. Usually, the overall plans of higher authority first become implemented at bureau and district levels. From these levels actual implementation of specific tasks continues on down the chain of command until all individuals in the Naval Establishment are involved.

The bureaus are involved in defense planning because of (a) their relationship to bureau-managed field activities and (b) their responsibility to develop protective measures that are commensurate with the strategic and logistic importance of individual activities.

At the district level, the first step in the preparation for ABC warfare defense is to establish an administrative organization that will designate, equip, and train disaster control forces. The designation of such an administrative organization and the composition of its command is detailed in Chapter 3 of the United States Navy Passive Defense Manual, OPNAV INSTRUCTION 3440.6. The outline of the disaster control organization is shown in Figure 5-1 and described briefly as follows.

1. DISASTER CONTROL FORCE. Under command of the district commandant, it is composed of disaster control groups designated as area commands and so designated by the commandant.

2. DISASTER CONTROL GROUP. Under command of a group commander so designated by the commandant. The area command is composed of units that are organized within its geographical limits.

3. DISASTER CONTROL UNIT. The disaster control unit is under the command of an officer who is designated by the disaster control group commander. Some of the larger naval stations may be able to organize complete units. Smaller stations, however, may

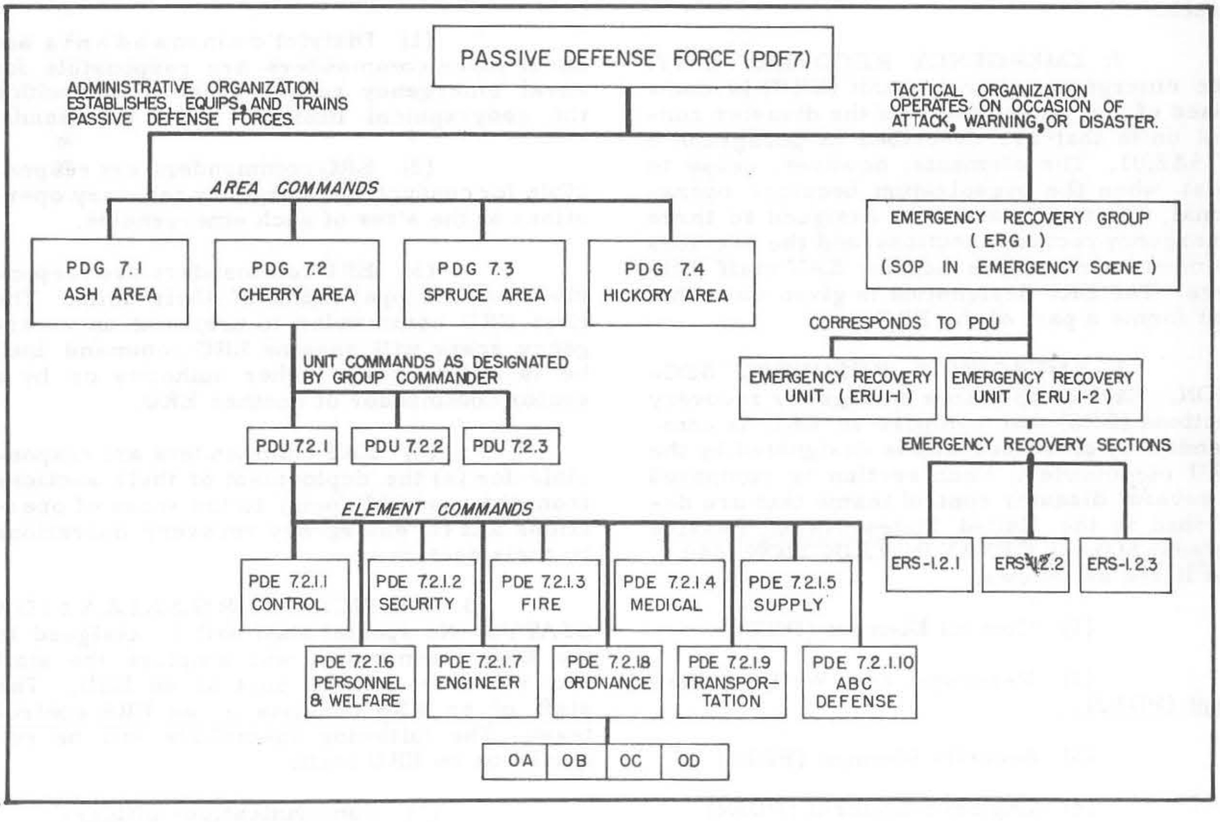


Figure 5-1. Outline of the Disaster Control Organization

be limited to one or more elements, or even a few teams. In all instances, it will be possible to combine the forces of several stations to form an integrated unit.

4. DISASTER CONTROL ELEMENT. The disaster control element is usually under the command of the department head who has cognizance over the particular element's function. The element commander is appointed by the unit commander.

5A2.02 COMMAND COMPOSITION AND DESIGNATION OF TACTICAL DEFENSE ORGANIZATIONS

The tactical disaster control organization is activated at the scene of attack or disaster, or on receipt of a warning. It consists of the following components.

1. EMERGENCY RECOVERY GROUP. The emergency recovery group (ERG) is under the command of the senior officer present (SOP) at the emergency scene. This group consists of one or more emergency recovery units that are deployed to the scene of attack, and it comes into existence at the scene of attack.

2. EMERGENCY RECOVERY UNIT. The emergency recovery unit (ERU) is composed of the same teams as the disaster control units that are described in paragraph 3 of 5A2.01. The elements, however, cease to exist when the organization becomes operational; the teams are then assigned to three emergency recovery sections, and the previous element commanders become ERU staff officers. The ERU designation is given when this unit forms a part of the ERG.

3. EMERGENCY RECOVERY SECTION. Each of the three emergency recovery sections (ERS) that compose an ERU is commanded by an officer who is designated by the ERU commander. Each section is composed of several disaster control teams that are described in the United States Naval Passive Defense Manual, OPNAV INSTRUCTION 3440.6, and listed as follows.

(1) Control Element (PDE1)

(2) Personnel and Welfare Element (PDE2)

(3) Security Element (PDE3)

(4) Engineer Element (PDE4)

(5) Fire Element (PDE5)

(6) Ordnance Element (PDE6)

(7) Medical Element (PDE7)

(8) Transportation Element (PDE8)

(9) Supply Element (PDE9)

(10) ABC Element (PDE10)

(11) Helicopter (PDE11)

5A2.03 RESPONSIBILITIES

Disaster control responsibilities at the operational level may be analyzed as follows.

1. ADMINISTRATIVE RESPONSIBILITIES. District commandants and naval force commanders are responsible for the readiness of their defense forces, and subordinate commanders are responsible for their assigned groups, units, and elements.

2. TACTICAL RESPONSIBILITIES. Tactical responsibilities are as follows.

(1) District commandants and naval force commanders are responsible for naval emergency recovery operations within the geographical limits of their commands.

(2) ERG commanders are responsible for conducting emergency recovery operations at the sites of such emergencies.

(3) ERU commanders are responsible for the operations of their units. The first ERU commander to arrive at an emergency scene will assume ERG command until he is relieved by higher authority or by a senior commander of another ERU.

(4) ERS commanders are responsible for (a) the deployment of their sections from the assembly point to the scene of operations and (b) emergency recovery operations by their sections.

3. TACTICAL ORGANIZATION STAFFS. No special staff will be assigned to the ERG commander, who employs the staff and recovery control post of an ERU. The staff of an ERS consists of an ERS control team. The following specialists will be required on an ERU staff.

(1) Communications officer.

(2) ABC control officer.

(3) Engineering and rescue officer.

(4) Medical officer.

(5) Public information officer.

(6) Fire officer.

(7) Security officer.

(8) Liaison officer to effect liaison and coordination of the naval effort with that of other armed services, federal agencies, and municipal and civilian organizations.

(9) Personnel officer, who will be responsible for survivor registration, evacuation, assignment, and welfare of personnel. He will also be required to advise staff on the availability of additional personnel for recovery operations.

(10) Transportation and routing officer.

(11) Supply officer.

The foregoing officers of the emergency recovery unit should be selected from appropriate disaster control element commanders and departmental officers of activities that are represented. Alternates should be designated in all instances.

PART B. ORGANIZATION FOR ABC DEFENSE

Section 1. ACTIVITY BILLS AND EQUIPMENT

5B1.01 NATURE AND CONTENT OF ACTIVITY PLANS AND BILLS

The administrative organization establishes, equips, and trains the various elements and their component teams. It is the responsibility of the commanding officer of the individual activity to make certain that an adequate activity bill and/or mobile support bill is prepared for any unit of the ERO that is assigned to his activity.

For example, assume that activity X has been assigned responsibility for the establishment, equipment, and training of a personnel decontamination team that is to function as one team of an ABC element. In this event the bill should contain the following information.

(1) Missions of ABC element, and chain of command.

(2) Missions of personnel decontamination team.

(3) Number and classification of personnel assigned to personnel decontamination team and their specific tasks.

(4) Identity and location of items of equipment and supply assigned to use by personnel decontamination team.

(5) Plan and schedule for training of personnel decontamination team.

(6) Plan for tactical deployment of personnel decontamination team.

In addition to the special bills that are made necessary by specific assignments, each naval activity must incorporate into its disaster control recovery plan specific functions, personnel assignments, and procedures to be employed for the following contingencies.

(1) Enemy attack

(a) Attack warning

(b) Warden assignments and shelters

(c) Dispersal and/or preattack evacuation

(d) Material readiness condition settings

(e) Self aid

(f) Fire detection

(g) Ground-air observation

(h) Activation and operation of control center

(i) Internal emergency communications

(j) Local emergency recovery operations

(k) Assembly and dispatch of teams to ERU assembly points

(2) Natural disasters and other emergencies

(a) Signals for fire and accidents

(b) Natural disaster procedures, including team assignments (for those types of natural disasters that may be expected in the locality).

5B1.02 PROMULGATION OF ACTIVITY PLANS

Station plans or mobile support plans that are prepared by a naval activity normally pass through the designated disaster control group commander to the commandant of the naval district for review and approval. When approved, they are returned through channels to the commanding officer of the naval activity with any required special directions for their implementation.

The naval activity must put the approved plans into effect. This involves notification of personnel who are concerned and any desirable indoctrination, if applicable. Indoctrination may be incorporated in the training program (paragraph 5B2.02).

5B1.03 ALLOWANCE LISTS

Each naval district has the responsibility for planning and organizing logistic support of its defense organization. The authority to work out the details that are concerned with organizational implementation, training, and planning may be delegated to disaster control group commanders who are in charge of district area subdivisions. These group commanders may, in turn, call upon the various individual activities to submit appropriate requests for equipment and supplies that are needed to equip the planned recovery forces.

1. PRINCIPLES FOR PREPARATION OF ALLOWANCE LISTS. In the preparation of requests for equipment and supplies, the following general principles should be considered.

a. Actual Requirements. Requests for special items of equipment, and particularly for individual protective items of equipment, must be based on actual requirements of elements and teams that have been brought into existence or provided for by station bills or mobile support bills.

b. Filling in to Standard Requirements. Many items of equipment and supply that are required by elements and teams of the ERO are items ordinarily on board at most naval activities. Conversely, various items of special equipment and supply are essential or useful in ABC warfare defense but are not ordinarily available at a naval activity.

Standard equipment and supply requirements for all standard ERU teams are listed in Appendix I of the United States Navy Passive Defense Manual, OPNAV INSTRUCTION 3440.6. To determine the actual equipment and supply needs of an individual activity, a list of the equipment and supplies that are on hand at the activity should be compared with the requirements that are listed in the aforementioned reference.

2. STATION REQUIREMENTS FACTOR. An exact determination of station requirements for items other than individual protective equipment is not easily made. The requirements of a station are believed to be a function of (a) the number of personnel on board and (b) the area that is covered by the station. A method of establishing a station requirements factor "F" is used on the basis of

$$F = \frac{1}{50} A + \frac{1}{10,000} P$$

where

A = functional area of the station in acres and an additional 300-ft safety zone,
P = number of personnel on board, and
F = station factor, which, when multiplied by a "C" factor, the value of which is determined for each item of special ABC warfare defense material, indicates the requirement of an activity for that item.

For additional information, refer to Basic ABC Allowance Planning (CONUS), NAVDOCKS TP-PL-10 (Confidential) for the "C" coefficient values of all special ABC warfare defense material.

EXAMPLE

If a station has 1,000 personnel and 200 acres, of which 50 acres are functional,

$$F = \frac{1}{50} \times 50 \text{ plus } \frac{1}{10,000} \times 1,000 = 1.1.$$

The "C" value for bleach is 2.0 tons. Therefore, this station's requirement will be 1.1 x 2.0 = 2.2 tons.

5B1.04 PROCUREMENT OF EQUIPMENT AND MATERIAL

Each applicable bureau has established, by special instruction, the procedure to be followed in the procurement of special ABC warfare defense material. Requests should be made in accordance with those instructions.

5B1.05 CARE OF EQUIPMENT AND MATERIAL

Special equipment and material that are necessary to provide a state of readiness in ABC warfare defense should, like any other equipment and material, be the object of regular periodic inspection, testing, and inventory. For additional information, see ABC Warfare Defense Material, Inspection and Storage, NAVDOCKS TP-PL-19.

Section 2. TRAINING FOR ABC DEFENSE

5B2.01 DEFENSE PREPARATION

In conformance with the requirements of United States Navy Regulations, the commanding officer of a naval activity must take all practicable steps to maintain his command in a state of readiness to perform its mission. After an ABC warfare attack on a shore station, the immediate mission is to restore the essential function of that station. Readiness, in this event, is a product of planning, organization, procurement of necessary equipment and supplies, and training. Training is of special importance in ABC warfare defense because of new weapons and agents involved and because new psychological reactions have been evoked.

5B2.02 BASIC INDOCTRINATION AND TRAINING

All naval activity personnel, both military and civilian, shall receive basic indoctrination and training in disaster control. The purpose of this phase of training is to gain familiarity with the nature and effects of ABC weapons and agents. More particularly, this basic phase of training should present the following:

(1) The dimension and character of disaster effects,

(2) The consequent need for defense measures and emergency recovery operations, and

(3) The primary means of self-help and survival.

The content of this basic indoctrination and training lends itself well to mass-training techniques, which involve the use of lectures, motion pictures, demonstrations, posters, pamphlets, and magazine articles. Industrial relations components of activities can often conduct this type of training effectively.

5B2.03 TRAINING OF DEFENSE COMPONENTS

Training of the teams that make up defense components is highly specialized and does not lend itself to mass-training techniques. Essentially, this specialized training is training in operational procedures as dictated by the missions of the teams and elements concerned. The disaster control officer, who is one of the key figures in this training program, must perform the following functions.

(1) Coordinate various training specifications and assist element commanders in the development of training objectives.

(2) Train team leaders so they will be able to train the personnel of their teams effectively.

(3) Act as liaison between element commanders and the industrial relations officer.

The other key figure in the training program at the activity level is the industrial relations officer, whose training mission is to:

(1) Furnish the disaster control officer with information regarding training problems,

(2) Conduct all mass training (basic indoctrination and training),

(3) Program the training of all types in accordance with specifications,

(4) Conduct team and element training where organic training resources will permit, and

(5) Maintain records of all training and render reports on training as required.

Specialized personnel of some teams are selected because they already possess certain basic skills, for example, personnel on ordnance disposal (OB) teams who have completed an explosive ordnance disposal course. Enrollment in courses that will be made available by the District Director of Training, for example, rescue and firefighting courses, will provide other types of personnel with an opportunity to acquire special skills.

5B2.04 DRILLS AND TESTS

In accordance with district instructions, the commanding officer of a naval shore station must schedule and conduct periodic tests of the mechanics of assembly, dispersal, evacuation, and abandonment. Personnel of the entire station will be involved. In addition, the officers in charge in the control center (which includes communications and wardens) will conduct exercises and drills, in accordance with programmed area or building-readiness tests, for personnel under their commands.

Periodic critiques or other evaluations should be made on the station's disaster

control readiness, the effectiveness of its training programs, and its efficiency in conducting exercises. The entire tactical disaster control organization should be subject to these critical estimates. As a result, all phases of defense readiness can be accurately evaluated and appropriate modifications can be inaugurated.

5B2.05 RETRAINING

The need for retraining, including drills and tests, is well known. Skills that are not exercised over long periods tend to become lost. Furthermore, personnel at naval activities, both military and civilian, are subject to change, which is accelerated after an emergency or enemy attack.

The schedule for retraining should therefore meet the following needs.

(1) Indoctrination and basic training of new personnel.

(2) Induction of new personnel into the ranks of appropriate ERU teams, and training in their duties.

(3) Refresher training of personnel who have already received training.

PART C. EMERGENCY OPERATIONS

Section 1. INITIAL RECONNAISSANCE AND SURVEY

5C1.01 ESTABLISHMENT OF PERIMETERS

In the emergency recovery operations that follow an ABC attack, the establishment of an obstruction perimeter and a support perimeter should be one of the first steps taken. Realinement of boundaries, however, may later become necessary when more complete data are available as a result of ABC and damage reconnaissance.

The obstruction perimeter is the boundary of the target area; it is established by points at which further progress toward ground zero is impeded by (a) debris that blocks access, (b) unacceptable contamination, or (c) fire. The support perimeter is the outer boundary of the target area; it is established by points within which either (a) debris is found in streets or (b) the "stay time" is established at one week.

5C1.02 DESIGNATION OF SECTIONS

The establishment of perimeters makes possible the designation of three sections, which become the area bases for emergency recovery operations. These sections are shown in Figure 5-2 and are described as follows.

1. SECTION I. Section I is represented by the area within the obstruction perimeter. An organized recovery effort can not be expected from installations in this area. After an atomic attack, structural damage will be severe, fires are likely to be raging, the radiological hazard will be high, communications will be nonfunctioning, and many survivors are likely to be injured in some manner.

2. SECTION II. Section II is the area between the obstruction perimeter and the support perimeter as shown in Figure 5-2. Moderate to light damage will occur in this section; most personnel will survive, although many will be injured. A tendency to panic and effect spontaneous evacuation probably will be exhibited by personnel who are not well trained and organized into teams.

3. SECTION III. Section III is outside the support perimeter and is occupied by emergency recovery forces in direct support of components that operate in Sections I and II. Structural damage in this section will be minor, and all facilities should remain operational except those that are in the path of an early fallout hazard. Emergency recovery forces should move into this area as soon as possible after an attack.

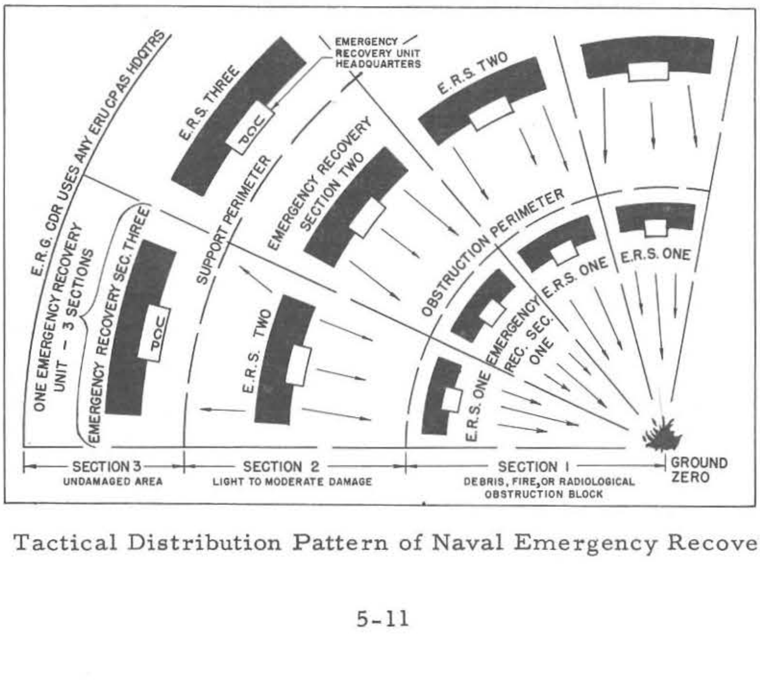


Figure 5-2. Tactical Distribution Pattern of Naval Emergency Recovery Forces

5C1.03 ABC AND DAMAGE RECONNAISSANCE

It is necessary that ABC and damage reconnaissance be instituted as one of the first phases of the emergency recovery operation. These early surveys, insofar as possible, must be conducted in all three sections. It is possible that portions of Section I may be so highly contaminated that they can not be surveyed except by aerial reconnaissance.

The teams that are primarily concerned in these early surveys are the damage survey team, aerial survey team, and route survey and communication team of the ABC element. The general mission of these teams is to (a) establish the location and extent of the emergency and (b) identify its hazards. The intelligence so provided forms the basis for the determination of the boundaries of perimeters and sections. Skill in the identification of locations is essential to this mission. Matters of general importance that should be reported include the location and extent of structural damage, personnel casualties and rescue requirements, route conditions, and radiation intensities.

1. ABC AND DAMAGE SURVEY TEAMS. ABC survey teams should be the first ground teams to enter an emergency area. Their specific task is to determine and report the location and intensity of radiological, biological, and chemical hazards. Damage survey teams should closely follow the ABC survey teams into the emergency area.

2. AERIAL SURVEY TEAMS. If an extensive and damaging attack occurs, the first reports on structural damage, fire conditions, and radiological contamination within the disaster area may come from the aerial survey teams. These teams report by voice radio, and the control center monitors and plots survey reports. The control center furnishes the ERG and/or the ERU commander with information. Aerial survey teams are particularly useful in coordinating the efforts of firefighters, because the members of these teams are able to evaluate overall fire conditions better than ground parties. For this reason, a professional firefighter should be included as a member of this team.

3. ROUTE SURVEY AND COMMUNICATIONS TEAMS. The route survey and communications team is also airborne and performs the important function of reporting on the possibility of access routes from assembly points to the emergency scene, as well as traffic, fire, and flood conditions. In addition, this team relays messages from mobile high-frequency radios on the ground, which would otherwise have a limited range of transmission.

5C1.04 SUBSEQUENT SURVEYS

ABC surveys and damage surveys do not end with the initial reconnaissance, although this is the first available basis for delineating perimeters and sectors. Later, and as time permits, further and more comprehensive surveys will provide additional information about the changing disaster scene. This information may call for modifications in the locations of perimeters. In addition, the detailed surveys will provide data concerning particular objects or areas that exhibit an unusually high degree of contamination. Information of this type is important, inasmuch as A, B, and C contaminations will tend to be "spotty" rather than uniform.

5C2.01 MEDICAL AID

The field-aid station is the base for first-echelon medical service and should normally be located in Emergency Recovery Operations Section II. This station will be used to resupply field first-aid teams, which move forward into Section I if conditions permit; they will be accompanied by litter-bearing teams. It is recommended that first-echelon medical service teams be moved in as units, each unit to consist of three field first-aid teams, four litter-bearer teams, one field-aid-station team, four ambulance teams, and, if necessary, two medical holding teams and two casualty decontamination teams. The relationship of the field-aid station to first-echelon teams is shown in Figure 5-3.

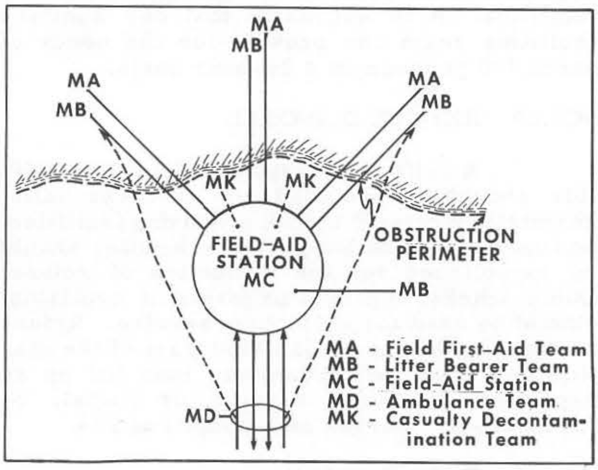


Figure 5-3. First-Echelon Medical Service Deployment

Second-echelon medical service is supplied by holding teams, improvised hospitals, and ambulance teams. Third-echelon medical service consist of (a) fixed medical installations and (b) specialized components such as the ABC health hazards team and the radiation sickness team.

5C2.02 EVACUATION OF CASUALTIES

By segregation of casualties according to the type and degree of their injuries, medical personnel will be able to provide the maximum amount of treatment for the largest number. The sorting begins with the field first-aid team, which directs ambulatory casualties to the field-aid station and provides first aid for nonambulatory cases.

At the field-aid station, diagnostic sorting of casualties takes place. Personnel with minor or moderate injuries are given primary treatment and eliminated from the chain of medical service. Those with more serious injuries are provided with supportive treatment and evacuated to second-echelon or third-echelon facilities.

5C2.03 PERSONNEL DECONTAMINATION

Contaminated personnel who have become casualties are decontaminated by casualty decontamination teams. To this end, some of these teams are assigned to field-aid stations in forward positions because, for radioactive substances and CW agents, early decontamination may be important. Medical personnel, however, will not decontaminate individuals who are not casualties.

Decontamination of noncasualty personnel is accomplished by the personnel decontamination (AB) and clothing decontamination (AF) teams of the welfare element in Section III and by the engineer station supervisors of Sections I and II. In the early stages of recovery operations, several AB and AF teams may be required. The resupply of decontaminated clothing may continue to be a major task for some time. This decontaminated clothing will be delivered to the clothing supply team or the special supply team for reissue.

5C2.04 PERSONNEL DOSIMETRY

The function of personnel dosimetry is accomplished by dosimetry teams (AE) of the ABC element. At the outset of operations, these teams should be assigned to field-aid stations and personnel and welfare stations in Sections I and II.

Personnel of dosimetry teams read nonindicating dosimeters and may be assigned the task of recharging self-indicating dosimeters for the various members of the recovery organization. This service is provided to both recovery team personnel and survivors of the attack. Readings will be used to help control stay times and assure that proper entries are made in medical records. The reading of the dosimeters is a continuing service that must be maintained as long as work parties operate in areas where residual radioactivity is present.

5C2.05 SURVIVOR CLASSIFICATION AND REGISTRATION

The personnel and welfare station is normally located in Section III in a position that will facilitate access by evacuation routes. Screening and disposition of survivors are accomplished at this station. Operations of the personnel and welfare element, as part of the emergency recovery operations, are likely to extend over several days.

Survivors, while being processed through the personnel and welfare station, are monitored, decontaminated if necessary, given first aid as required, and given dosimeter services and medical examinations. They are then classified, registered, and evacuated, as appropriate, to (a) civilian authorities, (b) military facilities, or (c) ERU pools.

5C2.06 EMERGENCY HOUSING

Emergency housing may be an immediate need during emergency recovery operations, and this requirement may continue to be essential for some time after the emergency stage.

This need is related not only to survivors, but also to off-duty teams of the ERU. The mission of providing shelter, sustenance, and sanitary facilities for such personnel is a mission for the rest and housing team of the personnel and welfare element. It is estimated that each team can provide facilities for about 400 persons.

5C2.07 EMERGENCY FEEDING

The provision of emergency messing facilities is the mission of the emergency messing team of the supply element. This team is provided with food supplies and equipment that will be necessary in setting up a field kitchen facility and messing facility.

One standard emergency messing team with standard equipment and supply is capable of providing for the food needs of 1,000 ERU members and survivors. Steps should be taken toward the rehabilitation and repair of mess halls. Equipment such as refrigerators, ranges, and steam tables should be repaired or replaced as necessary, and at least one cafeteria-type line should be opened for operation. All articles for food preparation and serving, such as pots, pans, dishes, and silverware, should be replaced or determined to be free from contamination. Arrangements should be made for (a) restocking the kitchen and (b) daily deliveries of food from outside the disaster area.

5C2.08 SANITATION

The provision of emergency sanitation facilities is a responsibility of the sanitary facilities team of the personnel and welfare element. To prevent the spread of disease, this team is equipped to haul and heat water, build field latrines and washing facilities, and supervise the policing of the area. Sanitary facilities should ordinarily be provided in the vicinity of resting and housing facilities. It is estimated that one sanitary facilities team can provide for the needs of about 400 persons on a 24-hour basis.

5C2.09 REFUSE DISPOSAL

A sufficient quantity of G. I. cans with lids should be provided for all mess halls, hospitals, first-aid stations, housing facilities, and operational buildings, and schedules should be established for the collection of refuse. Dump trucks, and/or dumpsters if available, should be used for collection service. Refuse should be taken to an isolated part of the station for disposal in sanitary land fill as an expedient measure, burning, or burial, or loaded aboard barges and dumped at sea.

5C2.10 PEST CONTROL

Strict rodent control measures should be instituted under the supervision of a pest and rodent control specialist. Food in galleys and mess halls should be properly safeguarded, and garbage cans should be kept tightly covered at all times. Refuse in dumps should be buried or burned. All possible sources of entry for rodents into food storage or preparation areas should be sealed. Fly and mosquito control should be effected. If window or door screens are damaged, they should be repaired as soon as practicable.

5C3.01 COMMUNICATIONS AND ELECTRICAL SYSTEMS

Immediate repair of damaged communications systems is one of the most vital emergency measures because it directly affects control of emergency operations. Such control will not be effective unless contact is maintained between the command post, emergency recovery stations, and the commanders of emergency recovery units and sections. At the same time, power from normal or auxiliary sources must be supplied to first-aid stations, emergency hospitals, and decontamination centers as rapidly as possible.

1. REPAIRS TO POWERLINES. Damage to poles and overhead lines will be caused principally by blast and falling debris. Telephone circuits between control points should be traced and all breaks spliced. Lines, after splicing, should be kept at least 16 feet above the ground and may be attached to buildings, stubs of poles, or improvised poles that are made from available lumber. Although underground lines are less likely to be damaged, underground vaults should be located and opened, and emergency repairs should be made if damage has occurred. Generating plants may be out of commission as a result of blast, in which event available auxiliary generators are the remaining recourse.

Extreme caution must be exercised in the repair of powerlines because of the hazard of live wires. In addition, electric service to damaged buildings should be shut off or cut off temporarily to avoid the possibility of secondary fires as a result of short circuits. As a fire-prevention measure, transformers and transformer vaults must be checked and spilled oil must be removed. Leaks must then be repaired and the transformers refilled.

2. EMERGENCY UNITS. If extensive damage has occurred to central power plants, their complexity may preclude repair during the emergency operation phase. Under such circumstances, emergency standby generators should be connected to the line and used until the central plant has been restored to operating condition.

After communications facilities have been restored among the command post and the control centers, the next operation to be undertaken is the emergency repair of the communications lines between the activity command post and the communications systems of other military commands and civilian defense agencies that are outside the disaster area.

5C3.02 WATER SUPPLY SYSTEMS

If the water supply system is damaged, it must be repaired immediately so that firefighting operations can be carried on effectively. An additional early hazard is the possibility that water from broken pipes may drown persons who are trapped in flooded basements or other low areas. Leakage must first be stopped to the maximum extent possible.

Water service to all damaged buildings should be shut off either at the street valves or at the water meters, whichever are more easily accessible, but water service to sprinkler-protected buildings that are in or near the fire area should be left on. The principal water mains should then be checked for breakage. If breaks are found in the mains, the water should be shut off at the nearest valve in the direction of the water supply and the break should be exposed by excavating. After the break has been exposed, it may be repaired by welding or other conventional methods, depending on whether the pipe is steel, cast iron, or asbestos fiber. Severe breaks may necessitate the replacement of entire sections of pipe. Quick coupling pipe can be used to accomplish the rapid replacement of damaged sections. Lengths of fire hose can be temporarily used to bridge breaks in mains. Local conditions will determine the most effective way to repair damage. The grasshopper technique of pipe laying, in which 4 to 6 joint sections are assembled ahead of the coupling crew, permits the effective use of the greatest number of repairmen at a time.

While emergency repair of pipelines is under way, an inspection of the pumping station should be made to determine the extent of damage. Inoperative pumps should be replaced with standby pumps, and necessary repairs and replacement should be made in the piping. If electrical power has not been restored, standby gasoline or diesel engines for driving the pumps should be readied and set in operation.

Section 4. REMOVAL OF DEBRIS

5C4.01 REESTABLISHMENT OF ACCESS

The plan for the removal of debris should provide for the opening of emergency access routes to a terminal point that is as close as possible to the area of virtually complete destruction. Operations should be carried out simultaneously on all of the selected routes. The initial objective should be the establishment of a trail that will be wide enough for two vehicles to pass. As time permits, the route may be widened and the surface leveled. After the arterials have been opened, access routes to personnel shelters and command posts and the peripheral roads can be cleared. Unless it is absolutely necessary, no attempt should be made to remove large quantities of debris from the site at this time. However, if the debris occurs in such quantities that its removal is essential, a suitable dumping site should be located nearby so that trucks can easily deposit the material.

5C4.02 DEBRIS CLEARANCE

In general, debris clearance during emergency operations should be confined to the work that is necessary for the removal of trapped personnel and the establishment of access routes to (a) the emergency scene and (b) areas within the station where firefighting is required. Access and rescue operations should be started simultaneously.

In the removal of debris for the rescue of personnel, only shovels, picks, and other standard handtools should be used. Because it is difficult to recognize a human body that is covered with debris, tools--especially picks--should be used with great care so that casualties will not sustain further injuries during rescue operations. Debris should be removed in baskets, buckets, and wheelbarrows to areas that are clear of the damaged buildings. Only when it is reasonably certain that no casualties are buried in the debris should cranes, power shovels, and bulldozers be put into action. All debris that has been moved in a rescue operation should be marked so that some other group will not handle it again in a search for casualties.

Access routes that are known to be free of casualties should be cleared of debris with power equipment so that firefighting apparatus and ambulances can be operated thereon as soon as possible.

5C4.03 ENGINEERING RESCUE

Rescue procedures consist of four phases: (a) immediate rescue, (b) exploration, (c) selected rescue, (d) and general rescue. Immediate rescue is a rescue that can be quickly accomplished or a rescue of injured persons who are not trapped. Exploration is the process of locating casualties who are trapped. Selected rescue is the rescue of casualties who have been located. General rescue is a systematic search that is made by stripping the area or building of debris so that missing persons can be located and rescued.

Engineering rescue includes categories (c) and (d); it requires the use of engineering methods and equipment to reach and rescue trapped personnel. Some of the methods used are tunneling, shafting, breaching walls, shoring walls and floors, trenching, raising and supporting structural members, removing walls and other hazards, and capping pipelines. To be effective, team members must be trained in first aid and must be well equipped with all the tools and safety gear that are required to accomplish their mission. Technical details concerning the engineering techniques involved are discussed in <u>Rescue Skills and Techniques</u>, Federal Civil Defense Administration, TM 14-1, Revised 1957.

5C4.04 REMOVAL OF HAZARDS

The partial destruction of buildings and industrial facilities produces many hazards that must be removed during emergency operations. Hazards are usually of two types: (a) structural hazards and (b) utility hazards. Structural hazards mainly consist of walls, floors, and roofs that are in imminent danger of collapse. Before remedial measures can be taken, it must be ascertained that all trapped persons have been removed. The partially destroyed buildings or industrial facilities can then be demolished by trained crews through the use of cranes and other power equipment. Utility hazards consist of (a) ruptured electrical, water, gas, and sewer lines and (b) escaping gases and chemicals that were used in refrigeration units and in certain industrial operations. Live wires present a serious hazard to trapped casualties and rescue personnel, and they are an ever-present possible cause of additional fires. Their removal should be attempted only by trained electrical linesmen. Water from ruptured mains may flood basements and endanger the lives of personnel. Rescue crews should shut off the water at the meters or the street shutoff valves. Gas lines should be shut off at the meters when a leak is known or suspected, because leaking gas can cause asphyxiation, explosion, and fire. Broken sewers may create problems of flooding and escaping gas. The use of open flames should be avoided when

sewer gas is present. Dams can be improvised to divert the flow of broken sewers away from trapped casualties.

5C4.05 CLEARING AND REPAIRING OF WHARVES

Wharves should first be inspected to determine whether they are structurally able to carry heavy debris-clearing equipment. If they are found to be in a safe condition, debris-removal crews should move in and clear them completely. After the debris has been removed, a further inspection should be made to determine the extent of structural damage. Damaged decking or deck slabs should then be removed, after which broken wood piling and/or sheet steel piling should be pulled.

5C4.06 CLEARING OF CHANNELS AND HARBORS

Major obstacles to navigation, such as damaged vessels and small craft, should be the first obstructions to be removed, and experienced salvage crews should be used in these operations. Priority should be given to channels and berthing areas, after which turning basins and anchorages should be cleared. After the major obstacles have been removed, floating cranes that are equipped with clamshell buckets can be used to clear sunken debris to the depth that is required for navigation.

5C4.07 CONTAMINATION PROBLEM IN HARBORS

The contamination of harbors is due chiefly to the presence of contaminated vessels and debris. The removal of these obstructions will, to a great extent, alleviate the problem. Changing tides and currents will further reduce the contamination to an insignificant level within a relatively short time.

5C5.01 RESTORATION OF STRUCTURAL SAFETY

To prevent buildings and structures from collapsing during recovery operations, temporary bracing and shoring will be necessary in many instances. If a wall is bulging or out of plumb, bracing, pushing, or raking shores should be used (Figure 5-4). A flying shore may be used when a sound adjacent wall is available as a means of support (Figure 5-5). Shores should be placed along a wall at intervals of 8 to 12 feet, depending on the situation, type of wall, and the extent of damage. Flying shores are not recommended for use between two walls that are separated by more than 25 feet.

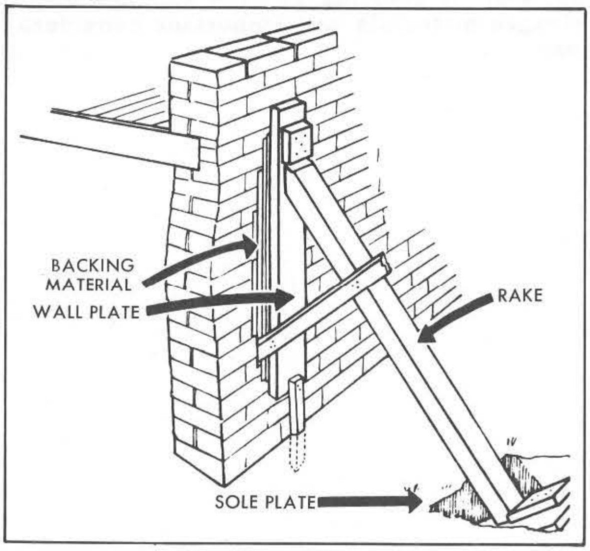
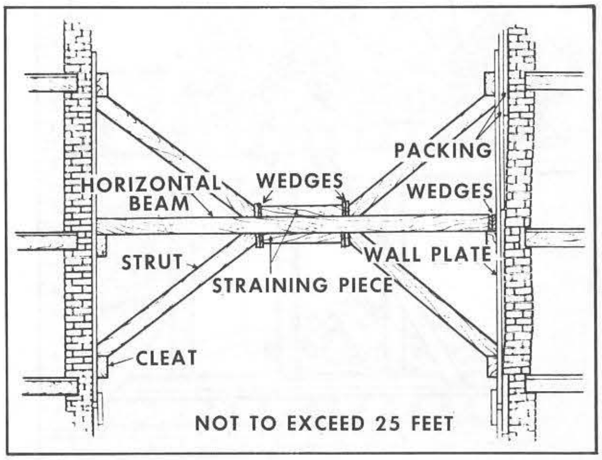


Figure 5-4. A Raking Shore



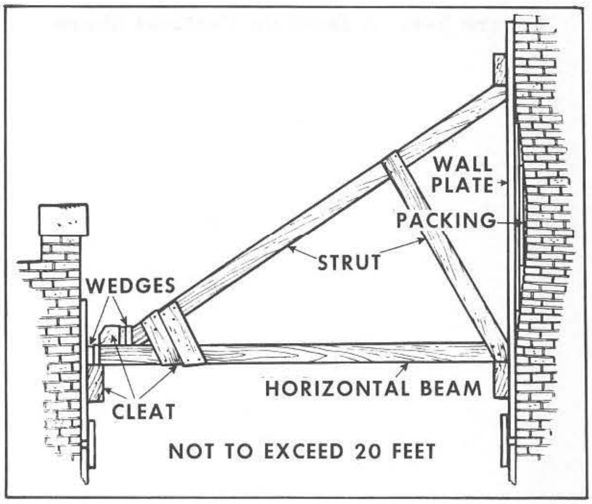


Figure 5-5. Flying Shores

Frequently, a weakened foundation or damage to the lower part of a wall makes the wall unstable. Because each damaged wall presents a separate and distinct problem, the method of shoring must be carefully planned and accomplished. In wall-bearing structures, the lower part of a wall and its footing, or foundation, must carry the entire weight of the structure above it. If the wall is damaged by blast or the removal of an adjacent supporting structure, it may buckle or crumble. Therefore, the bracing or shoring on lower parts of the wall should be stronger than corresponding work on the upper portions. Sagging floors and roofs should be supported by use of a dead, or vertical, shore, which is used to carry vertical dead loads (Figure 5-6). Strutting should be employed to strengthen window and door frames that have been made unsafe by cracked or damaged walls (Figure 5-7).

5C5.02 RESTORATION OF WEATHER-TIGHTNESS

As a temporary measure, weather-tightness can be restored by the use of an exterior grade of plywood. All holes in roofs and walls, and other openings, should be closed by nailing plywood panels over them. Clear plastic sheets should be used to cover damaged window and door openings so that light will enter.

5C5.03 CONSERVATION OF EQUIPMENT AND SUPPLIES

Because the repair of structures will require large quantities of critical materials

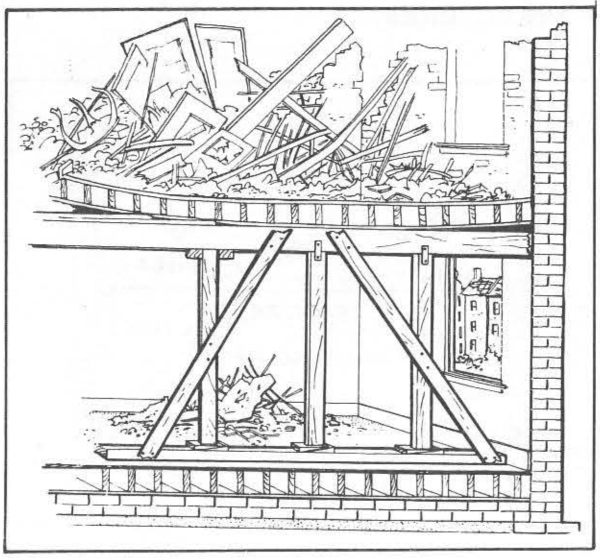


Figure 5-6. A Dead or Vertical Shore

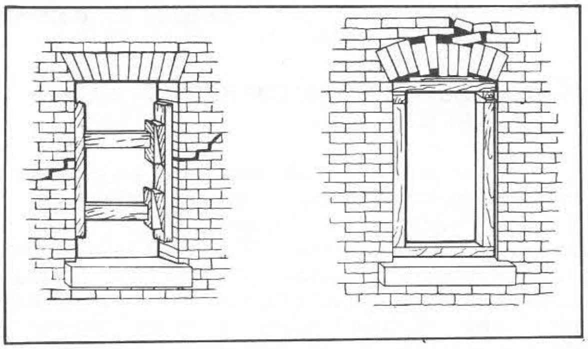


Figure 5-7. Window Struts

and supplies that may not be available, a priority system for their most economical use must be established and carried out. To this end, skillful planning and the efficient use of salvaged materials are important considerations.

5C6.01 CONVENTIONAL METHODS

Fires that are caused by an atomic explosion are both primary and secondary. After a large thermonuclear burst, a conflagration, that is, a great mass of fire that leaps barriers and frequently rages beyond control, will most likely result. The following general technique should be used to restrict the spread of a potential conflagration.

(1) All available firefighting forces and equipment are mobilized. Reserve apparatus is put into service, and auxiliary personnel and volunteers are utilized.

(2) Firefighting equipment is placed on the front quarter of the fire in an attempt to channel the path of the conflagration. This may bring the fire under control even when it is not feasible to apply water at a sufficient rate to absorb all the heat and extinguish the main fire. If possible, water barriers should be used in channelizing.

(3) Attempts are made to flank the fire and follow up the rear.

(4) Auxiliary units are deployed to patrol ahead and prevent the spread of fires by flying brands.

(5) Incoming engine equipment from surrounding communities is employed to bolster the existing water supplies either by the use of normal water sources or by relay pumping from distant points.

(6) When an attempt is being made to put out a fire in an individual structure, the building should be ventilated, the source of the fire located, the fire isolated if possible, and the flames extinguished.

5C6.02 FIREFIGHTING TEAMS

Six types of firefighting teams should be used to fight conflagrations; they are

(1) Firebreak supervision teams

(2) Engine teams

(3) Auxiliary hose teams

(4) Foam truck teams

(5) Portable pump teams

(6) Fire boat teams.

5C6.03 EMPLOYMENT OF FIREBREAKS

Firebreaks (paragraph 4F2.03) and alternate firebreaks are normally fire prevention measures that should be planned before the outbreak of fires. It is possible, however, that a conflagration may leap existing firebreaks and cause serious fires on both sides. The value of existing firebreaks must be determined on an individual basis and in terms of surrounding conditions at the time of the fire. It may be necessary to prepare additional perimeter firebreaks so that the spread of the conflagration will be limited.

Section 7. SECURITY AND TRAFFIC CONTROL

5C7.01 MAINTENANCE OF ORDER

Maintenance of order is of prime importance if emergency operations are to be carried out efficiently and expeditiously. Maintaining order is a police function. All personnel who have not been assigned to operating crews or pressed into service must be kept clear of recovery operations. Noncasualties should be assembled in evacuation areas and kept there until access roads have been cleared and transportation is available for their removal. Control of noncasualties is a primary responsibility of the security element in the defense organization. It is important to prevent hysteria among the personnel who are awaiting evacuation so that uncontrolled mass movement out of the devastated area on foot does not take place.

5C7.02 PREVENTION OF LOOTING

The assembly of personnel in evacuation areas for systematic mass removal will, to a large extent, prevent looting. Guards should be placed at food supply warehouses and armories, and roving patrols should cover other areas where looting might take place.

5C7.03 TRAFFIC CONTROL ON EVACUATION AND ACCESS ROUTES

Members of security teams, aided by traffic patrolmen and civil defense workers who have been trained in traffic operations, should be stationed at strategic points along evacuation and access routes to assure an orderly flow of traffic into and out of the devasted area. Priority of travel should be given to firefighting equipment, ambulances, and mobile support crews. All unauthorized vehicles must be kept out of the disaster area.

Section 8. RECLAMATION OF EQUIPMENT AND SUPPLIES

5C8.01 SALVAGE OF EQUIPMENT

In the course of the recovery, a considerable amount of equipment will be salvaged or reclaimed and put back into an operational status. In part, this process of reclamation depends upon the decontamination processes that are discussed in detail in Chapter 4, Part E.

Decontamination, however, is not the only factor that is involved in the reclamation of equipment. Some equipment will have sustained physical damage as a result of fire and blast effects. Metal parts of equipment that is housed in damaged buildings may be deteriorated and corroded. A decision on whether attempts at reclamation are justified must be made in the light of several considerations, including the following:

(1) The nature and extent of the impairment,

(2) The extent to which the equipment is of importance to operational recovery, and

(3) The degree to which the equipment is readily replaceable.

5C8.02 SALVAGE OF STORES

The salvage of stores presents a problem that is not unlike the problem of salvaging equipment. Some stores, including foods, can undoubtedly be salvaged in the course of the operational recovery phase. The nature of damage will vary greatly, but in the main will be the result of primary or secondary blast effects, fire, and contamination.

The same factors that are weighed in a determination of whether attempts at reclamation of equipment are justified should be considered for supplies.

Equipment and supplies that are adjudged to be unworthy of reclamation efforts because of persistent contamination should be buried on land or in the sea, destroyed by fire, or entombed.

A normal complement of stores, including special surpluses for defense use in the event of another attack, should be built up as rapidly as possible.

5C8.03 CRITERIA FOR DECONTAMINATION DURING RECOVERY

The process of decontamination, which may apply to AW, BW, or CW products and agents, will necessarily be in progress to some extent during the emergency recovery phase. However, in the early hours and days after an ABC warfare attack, decontamination will be largely limited to (a) access and evacuation routes and (b) structures and equipment that will be needed in recovery operations.

As recovery operations proceed, the situation will change materially, owing in part to the passage of time and in part to the effects of weathering. Radioactive decay, for example, will have been in progress continuously. Some BW agents may no longer be viable; others may remain hazardous and may even be on the increase. Certain CW agents will no longer persist, and others will remain active. The actual state of affairs can only be determined by monitoring, sampling, and testing. When contamination hazards remain, a decision must be made as to the feasibility and desirability of attempting decontamination measures, especially measures of a detailed nature that involve the expenditure of many man-hours. The factors that should be considered in reaching a decision and establishing priorities for decontamination efforts include the following:

(1) The extent to which materiel is vital to the process of regaining operational efficiency,

(2) The extent to which materiel can be readily replaced,

(3) The extent to which the use of areas is essential to recovery,

(4) The comparative difficulty of effecting decontamination, which varies considerably among different materiels, and

(5) Condition of decontamination materiel after attack.

Discussion of methods and materials that can be used will be found in Chapter 4, Part E of this publication.

PART D. OPERATIONAL AND FINAL RECOVERY PHASES

Section 1. OPERATIONAL RECOVERY

5D1.01 INITIATION

By definition, the emergency recovery phase consists of actions that will be taken immediately after an attack or disaster to keep the loss of life and property at a minimum. This phase of operations usually ends when the emergency group commander has determined that (a) all post-attack fires have been extinguished and (b) casualties are no longer being incurred to any considerable extent.

The operational recovery phase then begins. All efforts are directed toward the reestablishment of the station's normal function and capacity for performing its mission. At this stage, the ERU components normally cease to function as such, and the regular work organization of the station takes over.

5D1.02 FURTHER SURVEYS OF DAMAGE AND CONTAMINATION

Transition to the operational recovery phase does not mean that surveys and analyses of structural damage and ABC contamination come to a stop. In fact, they become more detailed and provide a more accurate picture of recovery requirements.

At this point, time is available for (a) the extended monitoring of structures, equipment, and supplies, (b) a determination of the feasibility of reclamation efforts, and (c) the location of radioactive hot spots. A decision is made on the abandonment or disposal of materials, and it is possible to begin to assemble estimates of reconstruction and replacement requirements.

5D1.03 CHANGES IN PERIMETERS

Detailed ABC monitoring also provides data on (a) the progress of neutralization or natural decay of contamination and (b) the effectiveness of decontamination measures that have already been taken. At the same time, it may be assumed that emergency recovery efforts have been successful in clearing certain access routes.

The initial situation with respect to access and contamination no longer exists, and a more accurate estimate of the damage has been obtained. Fires have been extinguished, and the situation with respect to access has been improved. It may therefore be desirable at this stage to change the locations of both the obstruction and the support perimeters.

5D2.01 RELATIONSHIP TO INITIAL DAMAGE

Actually, no break occurs between the operational recovery stage and the final recovery stage. Final recovery operations are largely a continuation and refinement of operations that were begun in the preceding stage. They may be defined as steps taken to restore all facilities that are required to accomplish the complete mission assignment of the station. At the end of the final recovery stage, the station must be as well or better prepared to carry out its mission than it was initially.

5D2.02 RELATIONSHIP TO PERSISTENCY OF CONTAMINATION

Some phases of organization and operation of a naval activity probably will be restored to full efficiency during the operational recovery stage. Other phases will be more difficult to reestablish for a variety of reasons, including the persistency of some types of contamination. Radiological contamination of a crater area, for example, may initially be at a high level. Although the radioactivity decays as time goes on, the area that is concerned may be something of an obstacle to recovery measures for a longer period than is tolerable. In such an event it may prove expedient to abandon the contaminated area and reestablish a portion of the station in areas that are not so affected.

5D2.03 DEGREE OF PERSONNEL CONTROL

In the course of the final recovery phase, personnel who have suffered relatively minor injuries will be restored to full duty. Replacement personnel will come on board to take the places of the dead and those who have been incapacitated. This necessitates a program of indoctrination and training in individual tasks that are necessary to the accomplishment of the mission of the activity. But it also means that all personnel must be indoctrinated and trained or retrained in the processes of ABC warfare defense. Final operational efficiency will not be achieved until the state of material readiness of the activity to resist ABC warfare attack equals the initial capacity of the activity.

5D3.01 RECLAMATION OF BYPASSED AREAS

In the process of the recovery and reclamation that has been described thus far, efforts have been concentrated on the rehabilitation and repair of administrative, operational, and housing facilities. Storage areas, parking areas, recreational facilities, theaters, and similar facilities have been bypassed. The debris removal crews should now be deployed to clear these bypassed areas. After the clearing operation has been completed, repair of utilities and structures should be undertaken, decontamination effected, and the areas gradually brought up to the state of repair of the remainder of the station. Operations for the reclamation of the bypassed areas, however, should be so scheduled that they do not interfere in any way with the final repair of vital facilities.

5D3.02 FINAL REPAIR OF ACCESS ROUTES

The final repair of access routes consists of finished grading, drainage, and repaving in accordance with existing criteria.

5D3.03 FINAL DECONTAMINATION

A final check should be made of all areas, buildings, facilities, stores, and equipment to determine whether any further decontamination is necessary. Those that are not within the allowable limits should be marked and charted, and decontamination squads should be dispatched to complete the work.

5D3.04 RESTORATION OF HARBORS AND CHANNELS

In the final phase, harbors and channels should be dredged to their original depths and widths. Underwater areas that are not in the path of navigation should be cleared of all sunken debris so it will not be a menace to small craft. Channel markers, buoys, and their chains and sinkers should be repaired and replaced as necessary.

5D3.05 NEW CONSTRUCTION

Many important buildings may have been entirely demolished by the blast. The local Shore Station Development Board should be convened to make a determination on which of these structures will require replacement. Priorities on the order of reconstruction should be established, and construction should be started as soon as practicable. It is advisable to make the greatest possible use of Bureau standard plans so that the time and cost of redesigning the structures will be reduced to a minimum.

APPENDIX A

ABC WARFARE DEFENSE MATERIEL

Appendix A contains a list of various items of equipment and material, arranged alphabetically under the following groupings, and paragraphs containing a description and pertinent information on most of the materiel.

Materiel	Items	Paragraphs
Detection Equipment	1 - 27	A1 - A24
Personnel Protection	28 - 67	A25 - A39
Group Protection	68 - 78	A40 - A49
Decontaminating Material	79 - 91	A50 - A60
Decontaminating Equipment	92 - 101	A61 - A65

Item no.	Type of equipment Individual items	Federal stock no.	Cognizant bureau	Figure	Par.
	Detection Equipment				
1	Alarm, G-agent, automatic, field, M6	C6665-339-5269	BuDocks	A-1	A1
2	Alarm, G-agent, automatic, field M6A1	C6665-572-5126	BuDocks		A1
3	Crayon, vesicant detector, M7	C6665-641-4231	BuDocks		A2
4	Crayon, vesicant detector, M7A1	C6665-112-9405	BuDocks	A-2	A2
5	Detector kit, chemical agent, M15	C6665-563-4145	BuDocks	A-3	A3
6	Detector kit, chemical agent, M18	C6665-551-1285	BuDocks	A-4	A4
7	Dosimeter, high-dose, indicating, IM-107( )/PD		BuShips		A5
8	Food testing and screening kit, chemical agents, M2	L6665-171-8945	BuMed	A-5	A6
9	Paper, liquid vesicant detector, M6	C6665-251-8358	BuDocks	A-6	A7
10	Paper, liquid vesicant detector, M6A1	C6665-285-6175	BuDocks	A-6	A7
11	Radiac computer-indicator, CP-95/PD	F6665-171-9566	BuShips	A-7	A8
12	Radiac detector, DT-60/PD	F6665-171-7970	BuShips	A-8	A9
13	Radiac detector charger, PP-345C/PD	F6665-599-9799	BuShips	A-9	A10
14	Radiac set, AN/PDR-10	F6665-318-3366	BuShips	A-10	A11
14a	Radiac set, AN/PDR-10A	F6665-286-1020	BuShips		
14b	Radiac set, AN/PDR-10B	F6665-414-0856	BuShips		
14c	Radiac set, AN/PDR-10C	F6665-286-0995	BuShips		
14d	Radiac set, AN/PDR-10D	F6665-599-6290	BuShips		
15	Radiac set, AN/PDR-18	F6665-355-5320	BuShips	A-11	A12
15a	Radiac set, AN/PDR-18A	F6665-355-5321	BuShips		
15b	Radiac set, AN/PDR-18B	F6665-286-1003	BuShips		
16	Radiac set, AN/PDR-27	F6665-263-3788	BuShips	A-12	A13
16a	Radiac set, AN/PDR-27A	F6665-171-8225	BuShips		
16b	Radiac set, AN/PDR-27C	F6665-286-1008	BuShips		
16c	Radiac set, AN/PDR-27D	F6665-286-1005	BuShips		

Item no.	Type of equipment Individual items	Federal stock no.	Cognizant bureau	Figure	Par.
	Detection Equipment				
16d	Radiac set, AN/PDR-27F	F6665-641-0228	BuShips		
16e	Radiac set, AN/PDR-27G	F6665-599-7799	BuShips		
17	Radiacmeter, IM-9( )/PD	F6665-263-3941	BuShips	A-13, A-14	A14
18	Reagent kit, M25, for M6 series G-agent alarm	C6665-339-5271	BuDocks	A-15	A15
18a	Reagent kit, low-temperature				A15
19	*Refill kit, biological agent, C17, for M17 sampling kit	L6665-299-9815	BuMed	A-16	A16
20	Refill kit, chemical agent detector, C15, for M15 kit	C6665-551-2160	BuDocks	A-17	A17
21	Refill kit, chemical agent detector, C18, for M18 kit	C6665-543-6642	BuDocks	A-18	A18
22	*Sampling kit, biological agent, M17	L6665-299-9814	BuMed	A-19	A19
23	Sign, atomic warfare contamination		BuSandA	A-20	A20
23a	Sign, biological warfare contamination		BuSandA	A-21	A20
23b	Sign, chemical warfare contamination		BuSandA	A-22	A20
24	Spare parts kit, M24, for M6 series G-agent alarm	C6665-339-5270	BuDocks		A21
25	Transformer-rectifier, M2, for M6 and M6A1 G-agent alarms	C6130-660-8083	BuDocks		A22
26	Water testing kit, chemical agents, screening, M2	L6665-171-9747	BuMed	A-23	A23
27	Water testing kit, poisons, M4	L6665-599-8919	BuMed	A-24	A24
	Personnel Protection				
28	Bag, waterproofing, M1, for M9A1 mask	C4240-377-9401	BuDocks	A-25	A25
29	Boots, knee, rubber	D8430-147-1018/1026 D8430-299-0340/0341	BuSandA BuSandA		

*Distribution will be made in accordance with training program that is established by the Bureau of Medicine and Surgery.

Item no.	Type of equipment Individual items	Federal stock no.	Cognizant bureau	Figure	Par.
	Personnel Protection				
30	Canister, spare, M10A1, for LWS mask, M3A1-10A1-6	C4240-127-7186	BuDocks	A-27	A26
31	Canister, spare, M11, for M9A1 mask	C4240-112-9365	BuDocks	A-26	A26
32	Cover, protective, individual (northern)	C8465-164-0512	BuDocks	A-28	A27
33	Cover, protective, individual (tropical)	C8465-164-0511	BuDocks		
34	Gloves, knitted, chemical warfare defense	D8415-268-7905	BuSandA		
35	Gloves, rubber	D8415-266-8686/ 8688	BuSandA		
36	Hood, gas mask, toxicological agents, protective, M4	C8415-281-2258	BuDocks	A-29	A28
	Impermeable protective clothing outfit, M3, (including the following items)		BuSandA	A-30	A29
37	Boots, knee, rubber	D8430-147-1018/ 1026			
38	Cover, boot, toxicological agents, protective, M3	D8430-262-5295/ 5297			
39	Cover, cooling, toxicological agents, protective, gas mask hood	D8415-261-6443			
40	Coveralls, toxicological agents, protective, M3	D8415-272-3022/ 3024			
41	Gloves, toxicological agents, protective, M3	D8415-261-6661			
42	Hood, protective mask, toxicological agents, M3	D8415-261-6690			
43	Suit, cooling, toxicological agents, protective coveralls	D8415-264-2929			
44	Impregnating outfit, clothing, field, M1	D4230-269-2908	BuSandA		A30
45	Impregnating set, clothing, field, M3	D4230-368-6145	BuSandA		A30
46	Isopropyl alcohol, NF, 5-gal	L6505-299-8095	BuMed		A31

Item no.	Type of equipment Individual items	Federal stock no.	Cognizant bureau	Figure	Par.
	Personnel Protection				
47	Leather dressing, vesicant gas-resistant, M1	G8030-174-3241	BuSandA		A32
48	Leather dressing, vesicant gas-resistant, M2	G8030-273-8719	BuSandA		A32
49	Mask, protective, field, M9A1	C4240-368-6093/ 6098	BuDocks	A-31	A33
50	Mask, protective, LWS, M3A1-10A1-6	C4240-288-6854	BuDocks	A-32	A33
51	**Medical supply set, gas-casualty treatment, No. 1	L6545-924-8125	BuMed		
52	**Medical supply set, gas-casualty treatment, No. 2	L6545-924-9675	BuMed		
53	**Medical supply set, gas-casualty treatment, for small units	L6545-924-4825	BuMed		
54	Overalls, men's, wet weather	D8405-268-8038/ 8039 8048/ 8049	BuSandA		
55	Overshoes, rubber, arctic, N-2	D8430-144-1640/ 1650	BuSandA		
56	Parka, man's, chemical warfare defense	D8405-268-7972/ 7975	BuSandA		
57	Parka, man's, wet weather	D8405-171-1419/ 1421	BuSandA		
58	Permeable protective clothing Five-man outfit Ten-man outfit	 G8405-261-6668 G8405-261-6667	BuSandA	A-33	A34
59	Protection and treatment set, chemical agents, M5A1	L6505-368-6152	BuMed	A-34	A35
60	**Protective clothing set, chemical agents	L6545-925-1695	BuMed		
61	Repair kit, field, M19, for M9A1 protective mask	C4240-574-2385	BuDocks	A-35	A36
62	Repair kit for LWS mask, M3A1-10A1-6	C4240-289-2052	BuDocks		A36

**Sets containing all items are furnished under a single stock number, FSN 6545-924-5675.

Item no.	Type of equipment Individual items	Federal stock no.	Cognizant bureau	Figure	Par.
	Personnel Protection				
63	Soap, surgical, 4-oz, with hexachlorophene	L6505-141-1900	BuMed		A37
64	Socks, men's, chemical warfare defense	D8440-177-8042/8046	BuSandA		
65	Trousers, men's, chemical warfare defense	D8405-266-8406/8409	BuSandA		
66	Water-purification tablet, iodine	G6850-250-2620	BuSandA		A38
67	Waterproofing set, C3, for LWS mask	C4240-287-4696	BuDocks	A-36	A39
	Group Protection				
68	Air lock, portable	C5410-272-9265	BuDocks	A-37	A40
69	Closure, protective shelter, antiblast, M1	C4240-606-7584	BuDocks	A-38	A41
70	Filter, gas, 150-cfm, M10, for M6 filter unit	C4240-203-8033	BuDocks	A-39	A42
71	Filter, gas-particulate, 600-cfm, M14, for M9 filter unit	C4240-300-6385	BuDocks	A-40	A43
72	Filter, particulate, 150-cfm, M9, for M6 filter unit	C4240-203-8018	BuDocks	A-41	A44
73	Filter unit, gas-particulate, M7A1	L4240-203-3999	BuMed		
74	Filter unit, gas-particulate, GED, 300-cfm, ABC, M6 (formerly collective protector)	C4240-203-0345	BuDocks	A-42	A45
75	Filter unit, gas-particulate, GED, 600-cfm, M9 (collective protector)	C4240-601-9612	BuDocks	A-43	A46
76	Manometer	C6685-273-7007	BuDocks	A-44	A47
77	Regulator, air pressure, M1	C5670-378-9876	BuDocks	A-45	A48
78	Valve, antibackdraft, M1	C5670-378-9875	BuDocks	A-46	A49
	Decontaminating Material				
79	Citric acid, commercial grade, 50-lb container	C6810-273-8696	BuDocks		A50
80	Citric acid, monohydrate, technical, (antiset M1), 6-1/2-lb container	C6810-663-3144	BuDocks		A51

ABC Warfare Defense Materiel (6 of 7)

Item no.	Type of equipment Individual items	Federal stock no.	Cognizant bureau	Figure	Par.
	Decontaminating Material				
81	DANC solution unit, 3-gal, M4	C6850-276-7342	BuDocks		A52
82	Decontaminating agent, STB	C6810-297-6653	BuDocks		A53
83	Detergent, wetting agent (liquid)	G7930-282-9699	BuSandA		A54
84	Detergent, wetting agent (powder)	G6850-249-8021	BuSandA		A54
85	ETO Freon dispenser, 50-ml, 12-oz, M1	C6810-664-0382	BuDocks	A-47	A55
86	Ethylene oxide gas in 15-lb cylinder	G6830-291-5007	BuSandA		A56
87	Formalin (formaldehyde solution)	G6810-291-8392	BuSandA		A57
88	Methanol (methyl alcohol)	G6810-275-6010	BuSandA		A58
89	Plastic coating, strippable	G8030-275-8094	BuSandA		A59
90	Sodium metabisulfite	G6810-281-4255	BuSandA		
91	Tape, adhesive, pressure-sensitive	G8135-266-5026	BuSandA		A60
	Decontaminating Equipment				
92	Decontaminating apparatus, portable, 3-gal, M1	C4230-272-3312	BuDocks	A-48	A61
93	Decontaminating apparatus, power-driven, skid-mounted, 400-gal, M4	C4230-142-2740	BuDocks	A-49	A62
94	Decontaminating apparatus, power-driven, skid-mounted, 400-gal, M6	C4230-142-2739	BuDocks	A-50	A62
95	Decontaminating apparatus, power-driven, trailer-mounted, 200-gal, M8	C4230-347-2436	BuDocks	A-52	A62
96	Decontaminating apparatus, power-driven, truck-mounted, 400-gal, M3A2	C4230-276-8930	BuDocks	A-51	A62

ABC Warfare Defense Materiel (7 of 7)

Item no.	Type of equipment Individual items	Federal stock No.	Cognizant bureau	Figure	Par.
	Decontaminating Equipment				
97	Decontaminating apparatus, power-driven, truck-mounted, 400-gal, M3A3	C4230-276-7341	BuDocks		A62
98	Dispenser, simulant agent, BGI, M1	6910-025-3274	BuWeps	A-53	A63
99	Generator, fog, insecticidal, 40-gph	C3740-132-8330	BuDocks	A-54	A64
100	Hypochlorination unit, water-purification, w/comparator	C4610-132-5453	BuDocks	A-55	A65
101	Portable fumigant atomizer, 3-gph	C3740-202-3093	BuDocks	A-56	A66

NOTE: The following publications provide information for determining allowances, inspection, and storage of special ABC warfare defense material.

ABC Warfare Defense Materiel Inspection and Storage, NAVDOCKS TP-PL-19, January 1959.

Basic ABC Allowance Planning (Continental Shore Activities and Outlying Bases), NAVDOCKS TP-PL-10 (Confidential), 1960.

Basic ABC Allowance Planning (Functional Components and Systems), NAVDOCKS TP-PL-11 (Confidential), 1960.

DETECTION EQUIPMENT

Items	1 - 27
Paragraphs	A1 - A24

A1. ALARM, G-AGENT, AUTOMATIC, FIELD, M6 and M6A1

a. Description. The field automatic G-agent alarm is supplied in two models: M6 and M6A1 (Figure A-1). Both are similar in appearance, size, and operation. Each is housed in an aluminum case that is 17 in. long, 16 in. wide, and 7 in. deep and weighs 24 lb. The case has removable front and rear covers, each of which is held in place by six snap catches. The complete operating unit comprises three separate packages: the alarm itself; a 24-volt storage battery or an M2 transformer-rectifier for connection to a 115-volt ac power line; and an M25 reagent kit, which contains the tape and chemicals. (See paragraph A15.) Each alarm must be serviced every 12 hours. One spare parts kit is furnished with every five alarms. (See paragraph A21.)

b. Use. The alarm is designed to sound a buzzer and light a warning light automatically when G-agents are present in the immediate vicinity to warn personnel to take protective measures. This alarm may be adapted also to activate local warning systems and controls of mechanical ventilation equipment.

c. Application. The field alarm must be placed on level ground or on a level platform. If the alarm is not level, the gravity feed of the chemical solution to the liquid pump will be affected. The normal operating temperature ranges from 32° F to 100° F. The following preparations are required prior to operation.

(1) Mix chemicals from the M25 reagent kit and pour them into the liquid tank of the field alarm.

(2) Bleed air from the liquid line to prevent an air lock.

(3) Install tape reel and filter disk.

(4) Connect to a power source of 24-volt dc or 115-volt ac through the transformer-rectifier.

Principles of operation are as follows. The paper tape, which is transported periodically through the alarm head, is wetted by a drop of the chemical solution. Air from outside the alarm is drawn first through a dust filter and then through part of the wetted spot on the tape. If G-agents are present in the air that is drawn through the tape, the chemical reaction of the G-agent with the solution on the tape causes the solution to turn pink. Light from an illuminating lamp shines onto the wetted spot on the tape and is reflected to two photoelectric cells. Light that is reflected from the pink portion of the spot is of lesser intensity than that from the white portion, which causes an unbalance between the photoelectric cells. This results in the sounding of a buzzer and the lighting of a light. The warning is continued until the alarm is reset by hand.

d. Effective Detection. This alarm detects G-agents in the surrounding air.

e. Limitations. This alarm has the following limitations.

(1) G-agents must be inducted into the alarm case to be detected.

(2) It detects only G-agents.

(3) Freezing temperature requires the use of isopropyl alcohol as an antifreeze.

(4) Chemicals must be added every 12 hours.

(5) The battery must be recharged periodically (for the M6 alarm).

(6) Nitrogen dioxide and chlorine substances produce false alarms.

f. Shipment. The M6 or M6A1 alarm is packed in a fiberboard box that weighs 41 lb and occupies 3.2 cu ft. The transformer-rectifier, the reagent kit, and the spare parts kit are packaged separately.

g. Reference Publications.

Instruction Book for Alarm, Field, Automatic, M6A1 (E21R2), Department of the Army Chemical Corps, EP-14-R2, 1958.

Instruction Book for Alarm, Field, Automatic, M6 (E21), Department of the Army Chemical Corps, EP-14, 1955.

h. New Alarm, G-agent, Automatic, Field, E41. A new alarm is being developed to replace the M6A1. If it is successful, this alarm will have the following advantages.

(1) The E41 will employ an insulated case in lieu of the bulky external heating jacket.

(2) The E41 is being designed to permit operation at ambient temperatures of -25° F or lower as compared with 0° F for the M6.

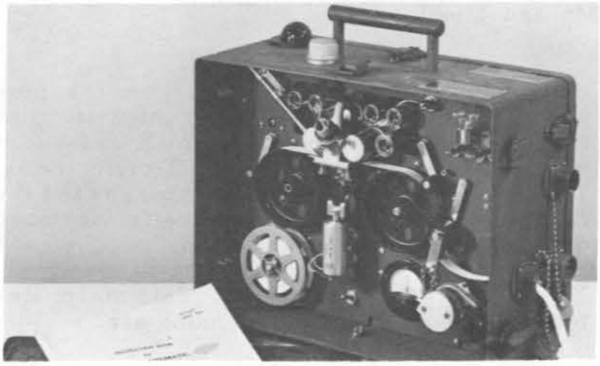


Figure A-1. Alarm, G-Agent, Automatic, Field, M6A1

(3) It has a self-contained power source, and it is thus not dependent on the availability of battery sources in the field.

(4) The unit that includes the integral power source is lighter than that of the M6A1 with its heavy external battery (that is, an estimated 25 to 30 lb compared with 100 lb). This is accomplished by the use of fewer and miniaturized components and the employment of transistorized circuity.

(5) The reduction and relocation of components will result in simplified maintenance procedures.

(6) The new E41 will operate for 24 hours without being serviced, as compared with 12 hours for the M6A1.

(7) Controls are on the outside of the alarm, which permits the operator to make adjustments without removing the covers. Adjustments are simpler and less critical than those of the M6A1.

(8) The E41 is less subject to faulty operation when it is tilted.

(9) The E41 is less susceptible to possible faulty operation under tropical conditions that effect electrical leakage caused by moisture.

(10) Light source in the E41 has a much longer life than that of the M6A1.

(a) The E41 uses a cadmium sulfide cell that is smaller and more sensitive than the photocell that is used in the M6.

(b) The battery that is being considered for use in the E41 (see item (3) above) is a zinc-silver oxide electrode type. It weighs about 12 lb. It can be charged about 40 times and has a life of 24 hours per charge. In cold weather this life is only 12 hours per charge.

(c) Work is currently under way to develop a transformer-rectifier as a source of power.

It appears that the E41 will not be standardized in the near future because there is a current requirement that CW alarms must be capable of detecting V-agents. This will delay the standardization.

A2. CRAYON, VESICANT DETECTOR, M7A1 and M7

a. Description. Vesicant detector crayons (Figure A-2) are pink, chalklike crayons that are used to detect the presence of liquid blister gases of vesicants and G-agents. Details concerning these crayons are as follows.

1. M7A1 Vesicant Detector Crayon. The M7A1 crayon is 2-3/4 in. in length and 0.44 in. in diameter. It is wrapped in waterproof paper for a length of 2-1/2 in. and is sealed in a plastic bag. Three bags, each containing one crayon, are packaged in an aluminum can that is 3-1/16 in. long. The can has a screw-on cap with a gasket to provide an airtight seal. Instructions for use are printed on the outside of each can.

2. M7 Vesicant Detector Crayon. The M7 crayon is 3-1/4 in. in length and 0.44 in. in diameter. It is wrapped in waterproof paper for a length of 3 in. and is packaged with 12 in a cardboard box. Instructions for use are printed on each box.

b. Use. When these crayons are rubbed on a surface, they produce a pink color, which changes to blue on contact with liquid vesicants or the concentrated vapors of vesicants. When a more positive identification of CW agents is required, the M18 or M15 chemical agent detector kit should be used. When drops of liquid G-agents are present, crayon markings or powder turn from pink to yellow.

c. Application. Crayons may be rubbed directly on firm surfaces. Crayon marks on white paper may be held against a suspected surface for five minutes. Dust from scraping or crumbling the crayons may be spread over a suspected surface.

d. Limitations. The M7A1 and M7 crayons have the following limitations.

(1) These crayons are not affected by the nitrogen mustards.

(2) They do not have high sensitivity and should not be used to test for the presence of CW agents in vapor form.

(3) They can not be relied upon entirely when they are used on recently decontaminated surfaces because they are affected by bleach, DANC solution, and M5 protective ointment.

(4) They are also affected by strong acids that may be formed when harmless compounds hydrolyze.

(5) Chlorine and phosgene in high concentrations turn the crayons blue.

e. Shipment. Both the M7A1 and M7 crayons are packaged in wooden boxes. Each box contains 372 crayons (or 124 cans), weighs 35 lb, and occupies 0.6 cu ft.

f. Reference Publications.

Individual Protective and Detection Equipment, TM 3-290, Department of the Army.

Military Chemistry and Chemical Agents, TP 3-215, Department of the Army.

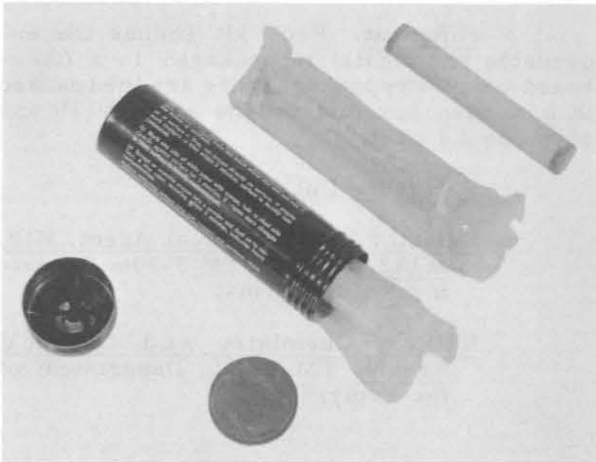


Figure A-2. Crayon, Vesicant Detector, M7A1

A3. DETECTOR KIT, CHEMICAL AGENT, M15

a. Description. The M15 detector kit (Figure A-3) is furnished in a carrier that is 5 in. by 3-3/4 in. by 2 in. and weighs 14 oz when filled. It is a simplified M18 detector kit. It is procured with the deteriorating (dated) chemical components furnished in the form of a C15 refill kit, which contains one set of chemicals for initial outfitting or for replacement. (See paragraph A17.)

b. Use. The M15 detector kit is designed to detect dangerous concentrations of G-agents and mustards. Air samples are drawn through detector tubes by an air-sampling bulb, as is done with the M18 kit. The details of the operation are the same as for the M18 kit, and instructions are included with each kit.

c. Effectiveness. The M15 kit will detect dangerous concentrations of mustard gases (H) and nerve gases (G).

d. Limitations. The M15 kit has the following limitations.

(1) It may be used to detect H, HD, and G-agents only.

(2) It is limited to fifty G or H tests.

e. Shipment. Each kit (minus the expendable chemicals) is packaged in a fiberboard box. Fifty packaged kits are then packed in a wooden box that weighs about 50 lb and occupies 2.1 cu ft.

f. Reference Publications.

Detector Kits, Chemical Agent, M18, M9A2, and M15, TM 3-306, Department of the Army.

Military Chemistry and Chemical Agents, TM 3-215, Department of the Army, 1956.

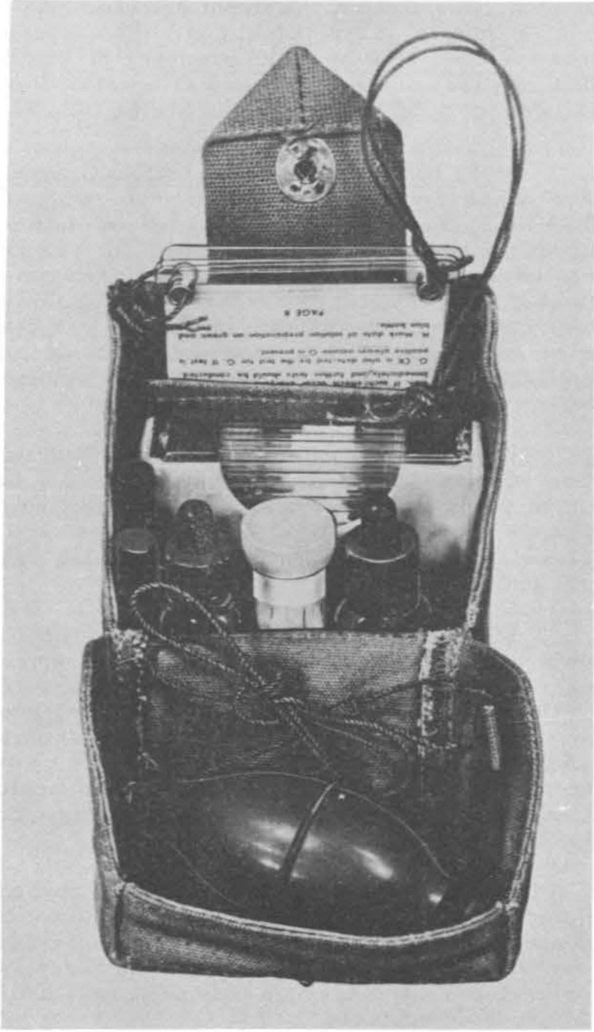


Figure A-3. Detector Kit, Chemical Agent, M15

A4. DETECTOR KIT, CHEMICAL AGENT, M18, and M9A2

a. Description. The M18 detector kit (Figure A-4) measures 8-1/2 in. by 5-1/2 in. by 3 in. and weighs 2-1/2 lb. It is packaged in a canvas carrier that contains a sampling bulb and accessories, less deteriorative supplies. A C18 refill kit (see paragraph A18) is provided to outfit and to replace dated chemicals. The M9A2 kit is substantially the same as the M18 kit.

b. Use. The M18 kit is used for reconnaissance in areas that are suspected to be contaminated with CW agents, for testing the presence of gas after decontamination operations, and for indicating when masks may be safely removed.

c. Application. The sampling bulb is used to draw vapors of CW agents through the detector tubes. Tests may be made also with the detector crayons and paper. Figure 4-4 describes the tests and contains instructions for reading the results.

d. Effectiveness. The M18 detector kit will detect dangerous vapor concentrations of the following agents: cyanogen chloride (CK), ethyl dichloroarsine (ED), hydrogen cyanide (AC), Lewisite (L), mustards (H), nerve gases (G), phosgene (CG), and phosgene oxime (CX). Vapors of all the agents listed above, except CX, are detected by the M9A2 kit.

e. Limitations. The M18 kit has the following limitations.

(1) Tests are not sufficiently rapid to be a guide in donning gas masks; therefore, if the presence of CW agents is suspected, masks should be donned prior to the use of the kits.

(2) A flashlight is necessary to identify colors at night.

(3) The M9A2 kit does not detect CX.

(4) The storage life of the reagents is six years, with the following exceptions.

Detector tubes	3 years
Detector crayons	3 years
Indole	2 years
Pyrophosphate peroxide	2 years, and perhaps as much as 3 years in some cases

f. Shipment. Each M18 and M9A2 detector kit (minus the expendable chemicals) is packaged individually in a fiberboard box. Eight kits are packed for shipment in a wooden box that weighs approximately 50 lb and occupies 2.1 cu ft.

g. Reference Publications.

Detector Kits, Chemical Agent, M18, M9A2, and M15, TM 3-306, Department of the Army, 1958.

Military Chemistry and Chemical Agents, TM 3-215, Department of the Army, 1956.

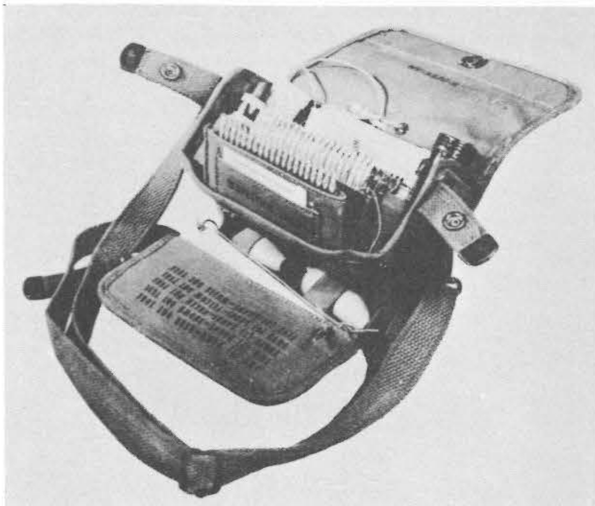


Figure A-4. Detector Kit, Chemical Agent, M18

A5. DOSIMETER, HIGH-DOSE, INDICATING, IM-107( )/PD

a. Description. The IM-107( )/PD radiacmeter consists of a watertight black barrel unit with a fountain pen clip that is located near the top.

b. Use. This dosimeter is designed to detect and indicate integrated doses of X and gamma radiation.

c. Application. These dosimeters are intended to be used by team members when they are operating in areas of high-level radiation.

d. Effectiveness. This high-dose dosimeter measures large increments of X or gamma radiation with an accuracy of ± 15 percent.

e. Limitations. The IM-107( )/PD has the following limitations.

(1) It will measure X or gamma dosage only up to 200 r.

(2) Light is required to read the radiation dosage, and the radiac detector charger, PP-354C/PD, is necessary to recharge, or rezero, the dosimeter.

f. Shipment. Depending on the model issue, the shipping size and weight will vary. It is shipped in a cardboard box that is 7/8 in. by 7/8 in. by 4-1/2 in. and the maximum weight is about 6 oz.

g. Reference Publication.

See NAVSHIPS 93268 Instruction Sheet, Radiacmeter-Dosimeter IM-107( )/PD.

A6. FOOD TESTING AND SCREENING KIT, CHEMICAL AGENTS, M2

a. Description. Analytical procedures have been developed to employ, as far as possible, dry, solid reagents and test papers to render the tests as simple as possible. The reagents are packed in a pocket-size transparent plastic container that is 6-1/4 in. by 3-3/4 in. by 2-7/8 in. and weighs 2-1/2 lb. The kit contains reagents for the detection of the nerve gases, mustards, arsenicals, and cyanogen chloride.

b. Use. The M2 kit (Figure A-5) is used to detect dangerous concentrations of the nerve gases (G series), mustard (H), nitrogen mustards (HN series), arsenical blister gases (L and HD), and the arsenical smokes (DA and DMO) on foods and food packages.

c. Application. A booklet that is issued with the M2 kit gives specific directions for making each test. These directions must be followed exactly. Briefly, the tests involve the following chemical processes.

(1) Arsenicals are identified by their ability to react with a special dye and to produce a red spot on the green paper.

(2) The mustards, both sulfur and nitrogen, are detected by means of a reagent impregnated in silica gel and bound to a test paper. A distinction between the sulfur and nitrogen mustards is made because of the fact that sulfur mustard will readily chlorinate and simultaneously liberate acid to change the color of a detector crayon from pink to blue. Nitrogen mustards do not change the color of the detector crayon.

(3) The nerve gases are identified by their reaction with two special chemicals to produce an orange or yellow color.

(4) The reactions may be summarized as follows.

Arsenicals	Red spot on green paper
Mustards	Blue or purple color
Nerve gases	Yellow or orange color

d. Limitations. The M2 food testing and screening kit has the following limitations.

(1) The test papers are packed to protect them against accidental contamination under normal circumstances; however, long exposure of an open kit to concentrations of mustards or arsenicals may result in contamination.

(2) The test papers should be examined critically, in accordance with the directions in the instruction booklet, prior to their use.

e. Shipment. Twenty-four kits are packed in a box that weighs about 45 lb and occupies 0.8 cu ft.

f. Reference Publications.

Food Testing and Screening Kit, ABC-M3, TB CML 41, Department of the Army.

Treatment of Chemical Warfare Casualties, NAVMED P-5041, 1956.

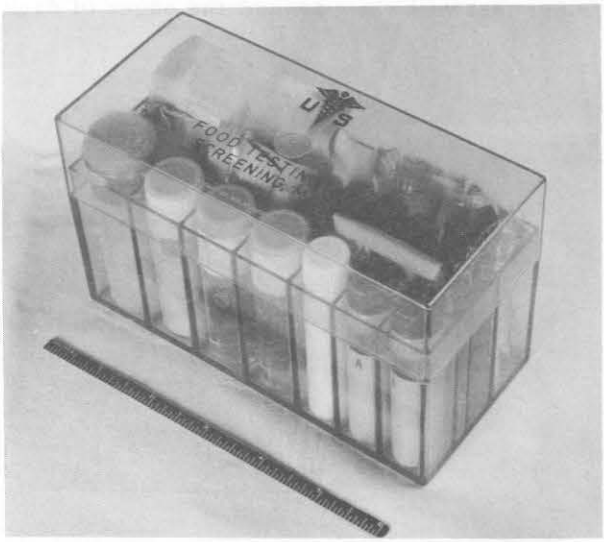


Figure A-5. Food Testing and Screening Kit, Chemical Agents, M2

A7. PAPER, LIQUID VESICANT DETECTOR, M6 and M6A1

a. Description. The M6 liquid vesicant detector paper (Figure A-6) is coated on one side with a special indicating paint. The paper is issued in booklets of 25 sheets, which are 5-1/2 in. by 5 in., with a 1/8-in. diameter hole in one corner. Because drops of certain chemical agents that are sometimes larger than 1/8 in. will penetrate permeable protective clothing, this hole is provided to assist in measuring the size of drops that fall on the paper. The M6A1 liquid vesicant detector paper is the same as the M6 paper except that each sheet is 2-1/2 in. by 4 in.

b. Use. The M6 and M6A1 papers are used to detect the presence of certain chemical agents that cause a change in color of the paper from olive green to red on contact with liquid or concentrated vapors of chemical agents.

c. Application. Sheets of paper are fastened, with the coated side upward, on horizontal surfaces in exposed locations at about 20-yard intervals.

d. Effective Detection. Liquid blister gas and G-agents are detected by a reddish fringe that will show around the edges of dark stains or large splashes of the contaminant. Vapors of blister gas and G-agents are detected by changes in color from olive green to various shades of red, depending on the concentration of vapors.

e. Limitations. The M6 and M6A1 papers have the following limitations.

(1) The paper has an outdoor sensitive life of about 3 months.

(2) Strong acids (HCL and H_2SO_4) and decontaminants (bleach, DANC, and M5) will affect the paper.

f. Shipment. One hundred booklets of the M6 paper are sealed in a waterproof envelope and packed in a wooden box that weighs 45 lb and occupies 1.0 cu ft. Two hundred booklets of the M6A1 paper are sealed in a waterproof envelope and packed in a wooden box that weighs 45 lb and occupies 1.0 cu ft.

g. Reference Publications.

Individual Protective and Detection Equipment, TM 3-290, Department of the Army.

Kit, Chemical Agent Detector, M18, M9A2, and M15, TM 3-306, Department of the Army.

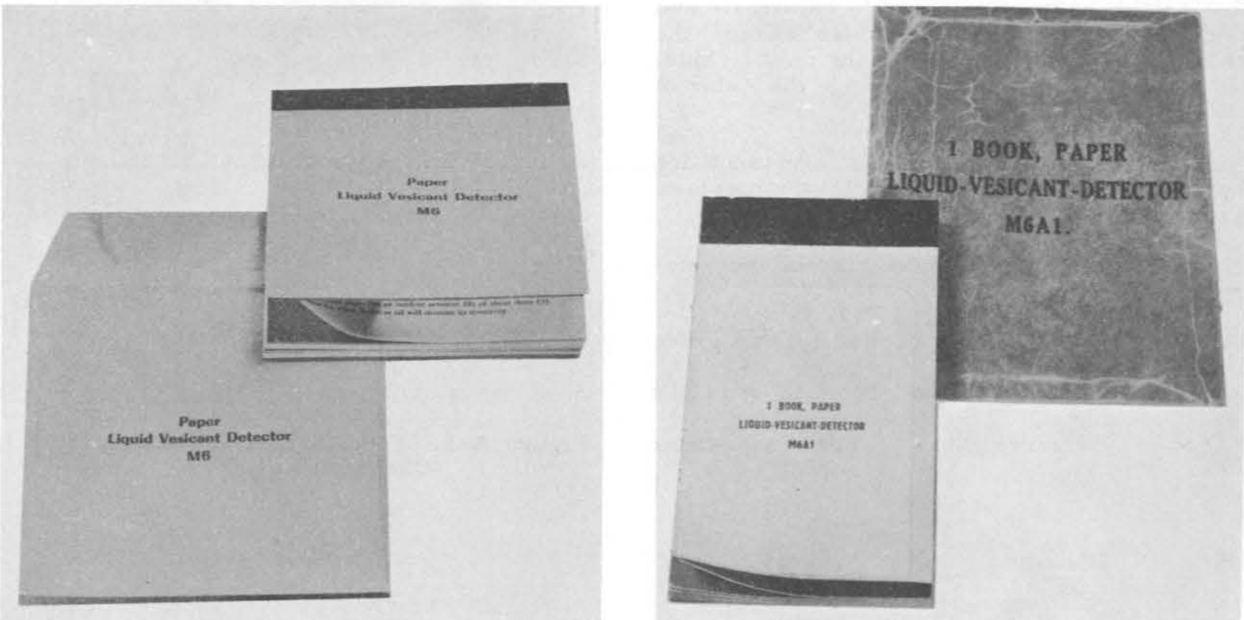


Figure A-6. Paper, Liquid Vesicant Detector, M6 and M6A1.

A8. RADIAC COMPUTOR-INDICATOR, CP-95/PD

a. Description. The CP-95/PD radiac computor-indicator (Figure A-7) consists of one basic unit, the front panel of which contains a cover assembly. This assembly contains a line cord and plug, plus miscellaneous spare parts.

b. Purpose. This computor-indicator is designed to be used to read the amount of radiation to which a DT-60/PD detector has been exposed.

c. Application. These indicators are for use primarily by dosimetry teams that are responsible for reading the DT-60/PD radiac detectors.

d. Effectiveness. Under normal conditions this indicator, which has a range of 0 to 600 r, is used to read the radiac detector DT-60/PD with an accuracy of ± 7 percent.

e. Limitation. One limitation of this radiac indicator is that it requires external power source (100 to 130 volts, 60 cps).

f. Shipment. The packaged weight of the equipment is 50 lb. Its shipping crate measures 13-1/2 in. by 27-15/16 in. by 13-5/8 in. These shipping data are for domestic shipment and include equipment spares.

g. Reference Publication.

Refer to the publication that is issued with the equipment, Instruction Book for Radiac Computor-Indicator, CP-95/PD, NAVSHIPS 92146. This book is for the model shown. Requests should be made for instruction book that describes the model at hand.

Figure A-7. Radiac Computer-Indicator CP-95/PD

A9. RADIAC DETECTOR, DT-60/PD

a. Description. The DT-60/PD radiac detector (Figure A-8) is a high-range, phosphor glass, nonself-indicating, watertight, circular device that is worn around the neck like a pendant.

b. Purpose. This instrument provides an economical means of determining the amount of X or gamma radiation, from 0 r to 600 r, that its wearer has accumulated.

c. Application. The detector will be issued to all personnel who are engaged in disaster control operations.

d. Effectiveness. This instrument measures large increments of X or gamma radiation with an accuracy of ± 20 percent above a dosage of 10 r.

e. Limitation. One limitation of the radiac detector is that it requires the use of a CP-95/PD radiac computer-indicator to read and indicate the amount of radiation to which the detector has been subjected.

f. Shipment. The detector is 1-1/2 in. in diameter, 3/8 in. in thickness, and weighs about 1 oz.

g. Reference Publication.

Radiac Detector, DT-60/PD, NAVSHIPS 91609A.

Figure A-8. Radiac Detector, DT-60/PD

A10. RADIAC DETECTOR CHARGER, PP-354C/PD

a. Description. The PP-354C/PD radiac detector charger (Figure A-9) is contained in a watertight metal case that measures 2-7/16 in. by 1 in. by 2 in. The charger has a hinged top, a removable plug on a metal chain, a bar-type knob, and a small window on the bottom.

b. Purpose. This instrument is designed to charge all self-indicating dosimeters.

c. Application. The charger is used to electrostatically charge self-indicating dosimeters before each use.

d. Effectiveness. This charger is effectively used with all self-indicating dosimeters.

e. Limitations. This detector charger has the following limitations.

(1) Light is required to illuminate the scale on quartz fiber dosimeters to permit the proper setting of the fiber.

(2) It is not feasible to repair the charger.

f. Reference Publication.

Instruction Book for Radiac Detector Charger, PP-354C/PD, NAVSHIPS 91432.

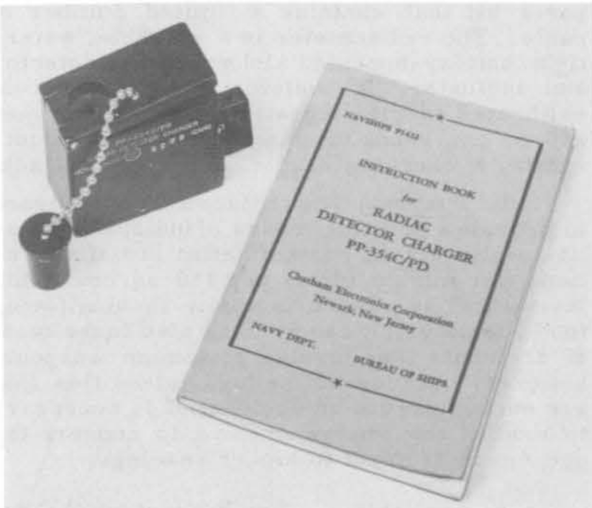


Figure A-9. Radiac Detector Charger, PP-354C/PD

A11. RADIAC SET, AN/PDR-10( )

a. Description. The AN/PDR-10( ) radiac set (Figure A-10) consists of a radiacmeter, carrying case with radioactive source, a headset, instruction books, and a maintenance parts kit that contains a limited number of parts. The radiacmeter is a portable, watertight, battery-operated alpha radiation detector and indicator. It contains a meter that is calibrated in disintegrations per minute per 150 sq cm, knobs for making external adjustments, a carrying handle, and a phone jack.

b. Purpose. The radiacmeter is designed to provide a portable means of indicating relative alpha surface contamination in disintegrations per minute (dpm) per 150 sq cm. This instrument is used principally in monitoring food and water. It can be used also in the event of accidents that involve plutonium weapons; however, because of the high intensities that are encountered in an accident, it is necessary to modify the window opening to convert the present instrument to higher readings.

c. Application. The headset of the set responds more rapidly to a change in radiation than does the meter. To locate the direction of increase of radioactive radiation, or the center of radioactivity, the headset indications must be utilized. When an absolute measurement of radiation is desired, the radiacmeter must be held still for a few minutes until the meter pointer reaches a maximum indication (it will oscillate about this point). A radioactive test source is mounted in the case of the radiac sets for quick operational checking.

d. Effectiveness. This radiac set is extremely sensitive to alpha radiation up to 10,000 dpm per 150 sq cm.

e. Limitations. The AN/PDR-10( ) radiac set has the following limitations.

(1) A few minutes are required to attain the correct scale indication.

(2) Repeated charging of the ionization chamber is required.

(3) The entrance window is covered with very thin aluminum foil that is easily punctured.

(4) This equipment is not recommended for use in measuring alpha contamination below 200 dpm per 150 sq cm.

(5) The instrument must be held within 1-1/2 in. of the source of the activity.

(6) Modification of the entrance window is necessary to measure dpm above 10,000 per 150 sq cm.

f. Shipment. The radiacmeter weighs between 8 and 9 lb and measures about 13 in. by 4-1/2 in. by 2 in., excluding the handle. The shipping weight of the radiac set varies, depending on the model. The maximum size is about 11-1/2 in. by 14 in. by 2-1/2 in. and the maximum shipping weight is 29 lb.

g. Reference Publication.

Instruction Book for Radiac Set, AN/PDR-10D, NAVSHIPS 92162. Requests should be made for the instruction book that describes the model at hand.

NOTE: The AN/PDR-10D may be jury-rigged to indicate an approximate hazard level of 14,000 dpm/sq cm, or 1,000 μg/sq m of PuO_2 at the top of the scale (reading of "10") by covering with masking tape all except two of the 172 grid holes. The two holes that are left open should be near the center of the entrance window (bottom grid). This is only an expedient and will not improve the low reliability and accuracy of this instrument. One or more correlation checks should be made with more accurate instruments. Efforts are under way to provide a better alpha radiacmeter for general Navy use. Also, efforts are under way to make an appropriate modification to the AN/PDR-10D radiacmeters to expand their reading level to meet the requirements indicated herein.

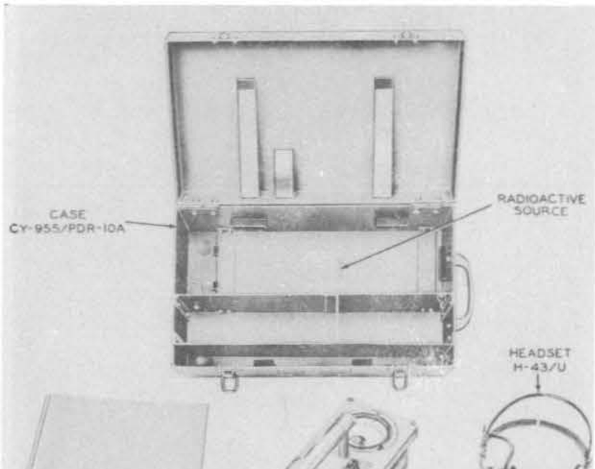


Figure A-10. Radiac Set, AN/PDR-10

A12. RADIAC SET, AN/PDR-18

a. Description. The AN/PDR-18 radiac set (Figure A-11) consists of a radiacmeter with a built-in radioactive test sample, a shoulder strap harness, a carrying case, instruction books, and miscellaneous spare parts. The radiacmeter is a portable, watertight, battery-operated gamma radiation detector and indicator. It contains an r/hr meter, knobs for making external adjustments, a carrying handle, and brackets for attaching the shoulder harness. The radiacmeter weighs between 8 and 9 lb and is about 11 in. by 5 in. by 4-1/2 in. in size, excluding the handle.

b. Purpose. This radiac equipment provides a portable means of detecting and measuring high-intensity gamma radiation of intensities up to 500 r/hr.

c. Application. The radiac set will be used by personnel to measure high levels of gamma radiation. The equipment is carried by means of the handle or the shoulder harness rather than by being mounted in fixed locations. It can be used for either ground or aerial surveys, which become the basis for locating radiation hazards and for determining the time that it is permissible to stay within an area.

d. Effectiveness. The radiac equipment is designed to measure high-intensity gamma radiation with an accuracy of ± 20 percent.

e. Limitations. The AN/PDR-18 radiac equipment has the following limitations.

(1) It requires the replacement of the batteries after about 40 hours of continuous operation.

(2) It can not be maintained in the field except for battery replacement.

f. Shipment. The shipping weight of the radiac set varies, depending on the specific model. The maximum shipping weight is about 35 lb. The maximum size of the box is about 18 in. by 11 in. by 12 in. and it occupies 1.4 cu ft.

g. Reference Publication.

Instruction Book for Radiac Set, AN/PDR-18B, NAVSHIPS 91662. This book is for the model shown. Requests should be made for the instruction book that describes the model at hand.

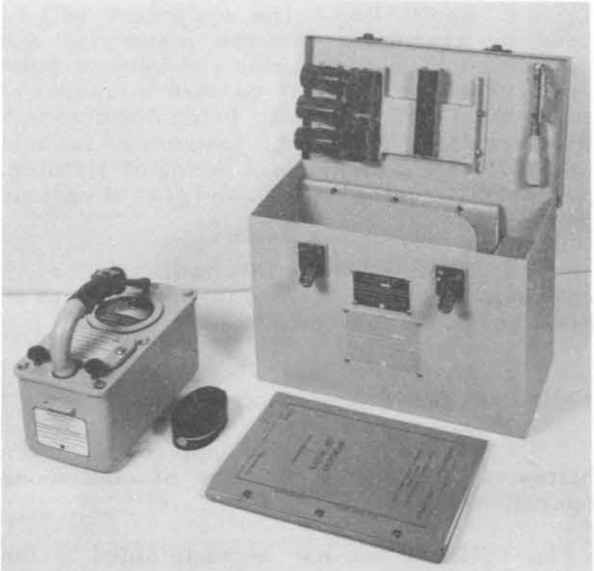


Figure A-11. Radiac Set, AN/PDR-18

A13. RADIAC SET, AN/PDR-27( )

a. Description. The AN/PDR-27( ) radiac set (Figure A-12) consists of a radiacmeter, a radioactive test sample, a shoulder strap harness, a headset, a carrying case, a probe, instruction books, and miscellaneous spare parts. It is a portable, watertight, battery-operated, radiation detector and indicator. The set contains a meter that gives a reading in mr/hr, knobs for making external adjustments, and a carrying handle and studs for attaching the shoulder strap harness.

b. Purpose. This radiac set provides a portable means of detecting beta radiation and of detecting and measuring gamma radiation for low intensities from 0 to 500 mr/hr.

c. Application. The equipment will be used by personnel who are measuring and detecting low-intensity beta and gamma radiation. The equipment is carried by means of the handle rather than by being mounted in a fixed location. This type of instrument is most useful for the detailed monitoring of clothing, personnel, interior spaces, and gear of various types.

d. Effectiveness. This radiac equipment is designed to measure low intensities with an accuracy of ±20 percent.

e. Limitations. The AN/PDR-27( ) radiac set has the following limitations.

(1) It requires the replacement of the batteries after about 40 hours of continuous operation.

(2) It can not be maintained in the field except for battery replacement.

(3) Beta radiations can be detected only when the detector is removed from the well and the beta shield on the end of the probe is moved aside.

f. Shipment. The equipment weighs approximately 10 lb and measures about 12 in. by 6 in. by 4-1/2 in., excluding the handle. The shipping weight varies, depending on the model. The maximum size of the box is about 28-1/2 in. by 21 in. by 28-1/2 in., and the maximum shipping weight is about 66 lb.

g. Reference Publication.

Instruction Book for Radiac Set, AN/PDR-27F, NAVSHIPS 91856. This book is for the model shown. Requests should be made for the book that describes the model at hand.

Figure A-12. Radiac Set, AN/PDR-27( )

A14. RADIACMETER, IM-9( )/PD

a. Description. The IM-9( )/PD radiacmeter (Figure A-13) consists of a low-range, self-indicating, watertight, black barrel unit with a fountain pen clip located near the top.

b. Purpose. This radiacmeter is designed to detect and indicate integrated doses of X and gamma radiation to a total capacity of 200 mr. (See Figure A-14.)

c. Application. The radiacmeter is used for training purposes and in hospitals and laboratories to measure the amount of X or gamma radiation that has been accumulated by personnel who are wearing the equipment.

d. Effectiveness. This instrument is sensitive to X or gamma radiation with an accuracy of ±15 percent.

e. Limitations. The IM-9( )/PD radiacmeter has the following limitations.

(1) It will measure X and gamma dosage only up to 200 mr.

(2) Light is required to read the radiation dosage, and the PP-354C/PD radiac detector charger is necessary to recharge, or rezero, the radiacmeter.

f. Shipment. The shipping size and weight of the radiacmeter will vary, depending on the model issued. It is shipped in a cardboard box that is 7/8 in. by 7/8 in. by 4-1/2 in., and the maximum weight is 6 oz.

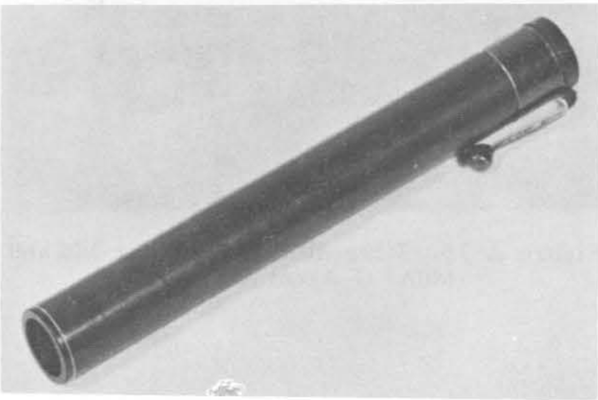
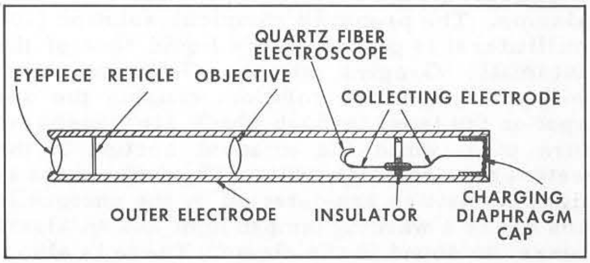


Figure A-13. Radiacmeter, IM-9( )/PD

g. Reference Publication.

Instruction Sheet, Radiac-Dosimeter, IM-9C/PD, NAVSHIPS 91698. This instruction sheet is for the model shown. Requests should be made for the instruction sheet that describes the model at hand.



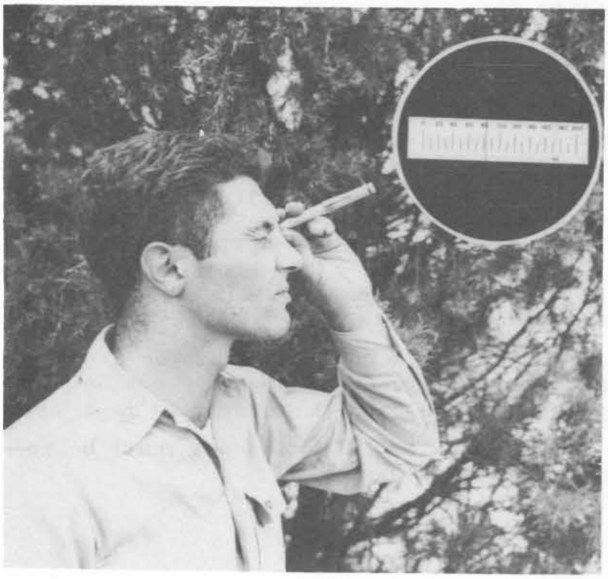


Figure A-14. Reading a Low-Range Pocket Dosimeter

A15. REAGENT KIT, M25

a. Description. The M25 reagent kit (Figure A-15) is supplied for the M6 and the M6A1 automatic G-agent alarms. It is packaged in a separate fiberboard carton that is 20-1/2 in. long, 6-1/8 in. high, and 17 in. wide. It contains 60 clear plastic packages of chemical powder, 60 aluminum foil packages of chemical powder, 60 paper filter discs, 60 reels of paper tape, a brown mixing bottle, and one color simulant spot.

b. Application. The M25 reagent kit is used to furnish the necessary expendable chemicals for the maintenance of the automatic alarms. The prepared chemical solution (100 milliliters) is placed in the liquid tank of the automatic G-agent alarm. G-agents react with the chemical solution, causing the wet spot on the tape, through which air passes, to turn pink, while the adjacent section of the wetted tape remains white. The differences in light intensities are detected by the photocells and cause a warning lamp to light and an alarm buzzer to sound in the alarm. There is also a low-temperature reagent kit for the M6 and M6A1 field automatic G-agent alarm, which is intended for use when the G-agent alarm must operate at temperatures between 32° and 0° F or lower. The low-temperature kit contains sufficient antifreezing chemical components for continuous operation for sixty 12-hr periods, or one month's supply. The component system is based on a 90-day resupply; therefore, sufficient chemicals are provided for a 90-day period of continuous operation.

c. Limitations. The M25 reagent kit has the following limitations.

(1) The chemical must be prepared and used immediately and should not be prepared in large batches for several days' use.

(2) The 50-foot tapes must be replaced every 12 hours.

(3) Because the reagent kit is synchronized with the alarm mechanism, it is necessary to add isopropyl alcohol to the mixture for low-temperature operation.

d. Shipment. The M25 reagent kit is shipped in a fiberboard carton that weighs 14 lb and occupies 1.4 cu ft.

e. Reference Publications.

Instruction Book for Alarm, Field, Automatic (E21R2) M6A1, EP 14-R2, April 1958.

Instruction Book for Alarm, Field, Automatic (E21) M6, EP 14, March 1955.

Figure A-15. Reagent Kit, M25, for M6 and M6A1 G-Agent Alarms

A16. REFILL KIT, BIOLOGICAL AGENT, C17, FOR M17 SAMPLING KIT

a. Description. One C17 biological agent refill kit (Figure A-16) contains all the expendable items that are necessary to completely reoutfit one M17 biological agent field sampling kit, (see paragraph A19) including a petri dish and a filter package assembly, broth, vials with swab fluid, impinger fluid, empty vials, swabs, plastic bags, and pencil lead.

b. Use. The C17 refill kit provides material for additional sampling that is beyond the capability of the M17 biological agent field sampling kit.

c. Shipment. The C17 kit is packaged in a fiberboard box that measures 5 in. by 13 in. by 6-1/2 in., occupies 0.25 cu ft, and weighs 5-1/2 lb.

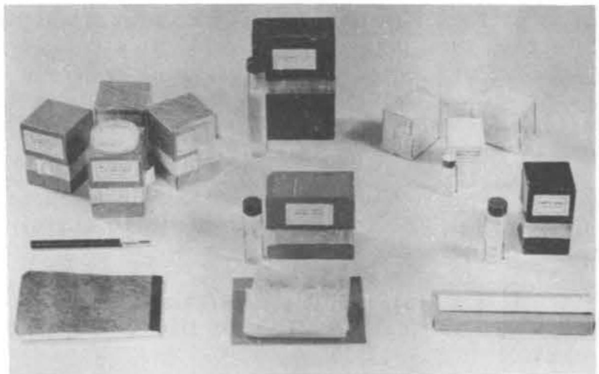


Figure A-16. Refill Kit, Biological Agent, C17, for M17 Sampling Kit

A17. REFILL KIT, CHEMICAL AGENT DETECTOR, C15, FOR M15 KIT

a. Description. The C15 chemical agent detector refill kit (Figure A-17) is a component part of the basic M15 chemical agent detector kit. It consists of the reagents and detector tubes that are required to fill or refill one detector kit.

b. Use. The C15 refill kit is used to outfit initially or to replenish one M15 chemical agent detector kit.

c. Limitation. One limitation of the C15 refill kit is that its storage life is about 3 years.

d. Shipment. Each refill kit is packaged in a fiberboard box that is about 4-3/8 in. by 3-1/2 in. by 2-1/2 in. One hundred packaged kits are shipped in a wooden box that weighs about 70 lb and occupies 2.2 cu ft.

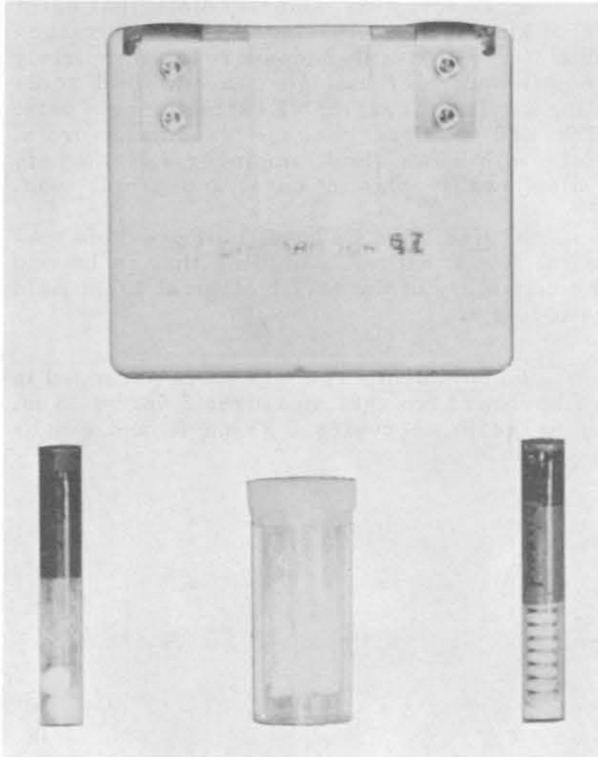


Figure A-17. Refill Kit, Chemical Agent Detector, C15, for M15 Kit

A18. REFILL KIT, CHEMICAL AGENT DETECTOR, C18, FOR M18 KIT

a. Description. The C18 chemical agent detector refill kit (Figure A-18) is a component part of the basic chemical agent detector kit. It consists of the reagents, detector tubes, and M7A1 crayons that are required to fill or refill one detector kit.

b. Use. The C18 refill kit is used to outfit initially or to replenish one M18 chemical agent detector kit.

c. Limitation. One limitation of the C18 refill kit is that its storage life is approximately 3 years.

d. Shipment. Each C18 refill kit is packaged individually in a fiberboard box that is approximately 5 in. by 3 in. by 2-1/2 in. Ten packaged refill kits are shipped in a wooden box that weighs about 25 lb and occupies 0.7 cu ft.

e. Reference Publication.

Detector Kits, Chemical Agents, M18, M9A2, and M15, TM 3-306, Department of the Army, 1958.

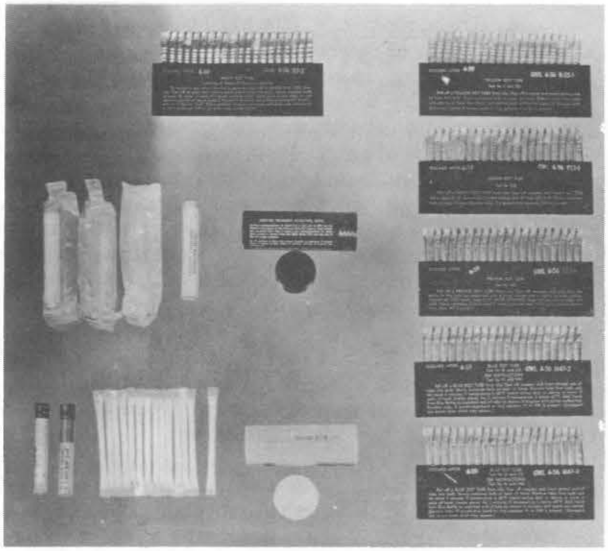


Figure A-18. Refill Kit, Chemical Agent Detector, C18, for M18 Kit

A19. SAMPLING KIT, BIOLOGICAL AGENT, M17

a. Description. The M17 biological agent sampling kit (Figure A-19) is packed in a plastic carrying case that measures 13-5/8 in. by 10-3/4 in. by 6-1/4 in. and weighs 20 lb. It contains a vacuum pump, membrane filters, an impinger, a plastic dish and blotter, nutrient syrettes, impinger fluid and antifoam solution, a sump tank, cotton swabs, gelatin diluent, filter holders, an incubation vest, plastic bags, hydrosol filtration units, decontamination equipment, rubber gloves, and miscellaneous equipment and instructions.

b. Use. The M17 sampling kit is for use by ABC Survey Team personnel in the collection of samples of materials for transportation to laboratories for identification.

c. Application. A vacuum pump is used to draw organisms into the impinger fluid and to transfer organisms to membrane filter by simple filtration. Filters are placed in plastic dishes with a suitable nutrient; or, if virus is suspected, the filtrate is refrigerated, preferably with dry ice, for transporting to the laboratory for identification.

d. Effectiveness. The M17 sampling kit will collect and preserve most of the known BW organisms for subsequent detection or identification at a laboratory. The nutrient in the M17 sampling kit supports most natural organisms as well as the BW agents.

e. Limitations. The M17 sampling kit has the following limitations.

(1) The sampling kit is used to collect samples for laboratories only, and it is not used to identify organisms on the spot.

(2) The sampling kit will process about 20 samples, after which it is necessary to replenish the expendable items from the refill kit.

f. Shipment. The M17 kit is shipped in a wooden box that weighs 39 lb and occupies 1.4 cu ft.

g. Reference Publications.

Military Biology and Biological Warfare Agents, TM 3-216, Department of the Army.

Tactics and Techniques of Chemical, Biological, and Radiological Warfare, FM 3-5, Department of the Army.

CBR Training Exercises, FM 21-48, Department of the Army.

Chemical and Biological Warfare Defense, NAVPERS 10098, Department of the Navy.

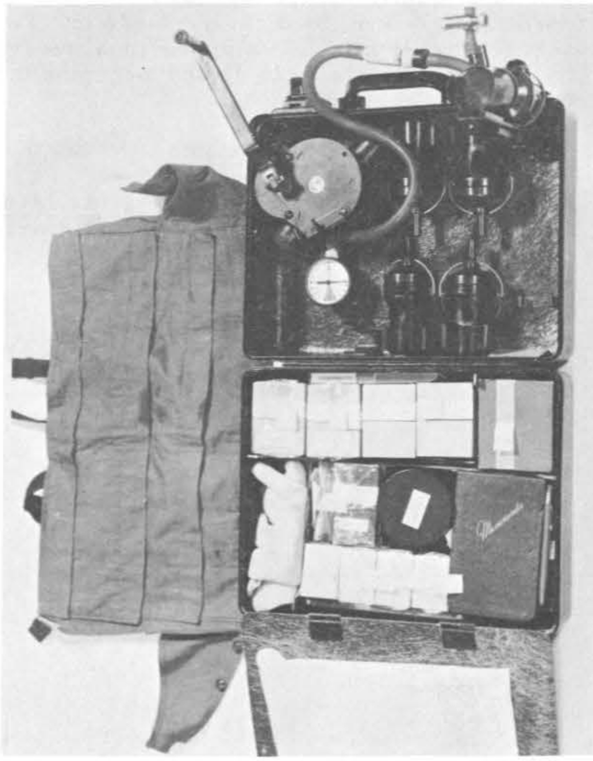


Figure A-19. Sampling Kit, Biological Agent, M17

a. Description.

(1) The atomic warfare contamination marker (Figure A-20) is a right-angled isosceles triangle that is made of paperboard, with 8-in. sides, 11-1/2-in. base, and 1/16-in. thickness. Both sides have the word "ATOM" printed in three positions, in 1/2-in. upper-case black gothic type on a white background, parallel with each side. A 3/4-in. black stripe runs from the center to each corner on the front side only.

(2) The biological warfare contamination marker (Figure A-21) is the same size and shape as the AW sign and made of the same material. Both sides have the work "GERMS" printed in three positions, in 1/2-in. upper-case black gothic type on a red background on the front only, and on a white background on the reverse side, or back. A 3/4-in. yellow stripe runs from the center to each corner on the front side only.

(3) The chemical warfare contamination marker (Figure A-22) is the same size and shape as the AW and BW signs and made of the same material. Both sides have the word "GAS" printed in three positions, in 1/2-in. upper-case black gothic type on a yellow background on the front side only, and on a white background on the reverse side, or back.

b. Use. These markers are used to define the boundaries of contaminated areas.

c. Application. The markers are nailed to short posts that are driven into the ground at approximately 100-ft centers with the front side facing away from the contaminated area. Markers are spaced close together enough for personnel who are approaching a contaminated area to see them and determine the boundary and to recognize the type of contamination.

d. Limitation. One limitation is that these signs can not be seen at night.

e. Shipment. Each type of sign is wrapped with 50 to a package.

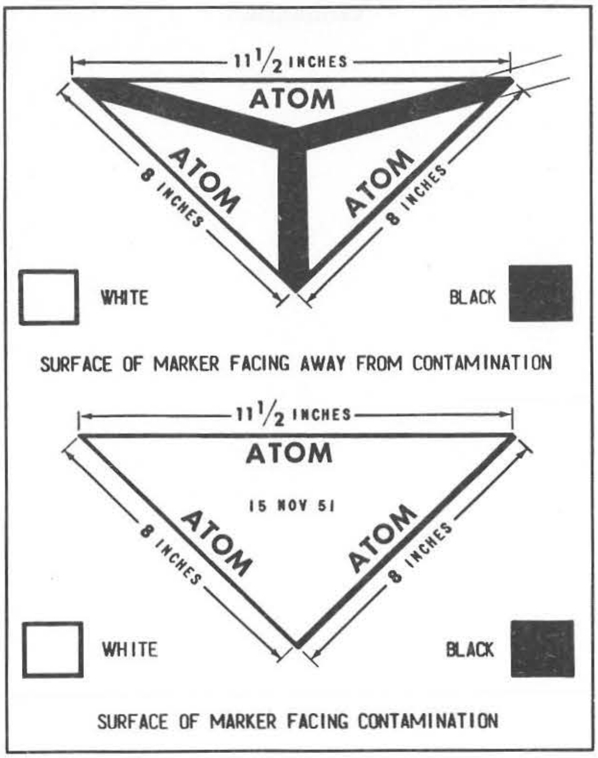


Figure A-20. Sign, Atomic Warfare Contamination

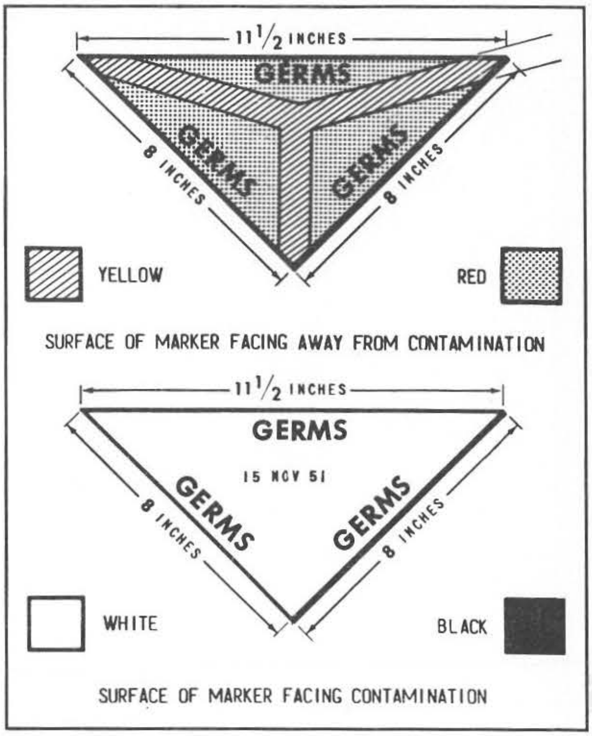


Figure A-21. Sign, Biological Warfare Contamination

f. Reference Publication.

Defense Against CBR Attack, FM 21-40, 1954, Department of the Army.

NOTE: Contamination markers are no longer furnished by the Bureau of Yards and Docks, but they shall be procured from BuSandA, Forms and Publications Supply Distribution Points, Norfolk, Virginia; Oakland, California; and the Naval Weapons Plant, Washington, D. C.; in accordance with BuSandA Manual, Volume II, Chapter 3.

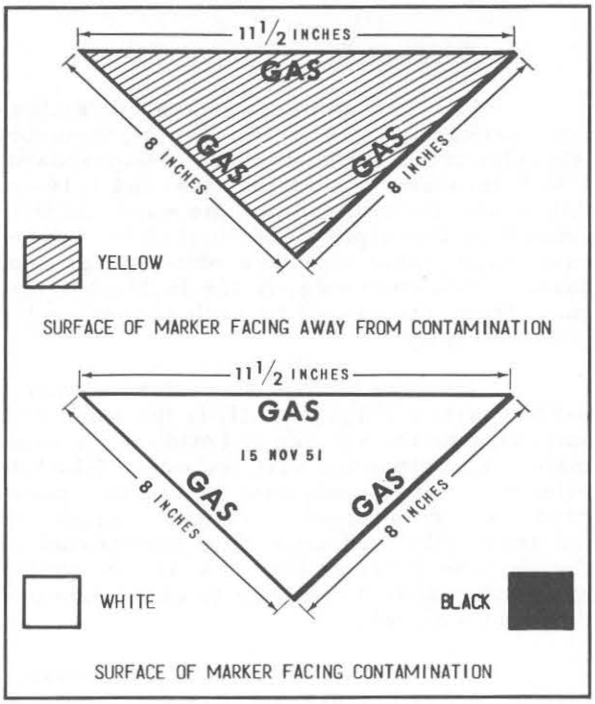


Figure A-22. Sign, Chemical Warfare Contamination

A21. SPARE PARTS KIT, M24, FOR M6 G-AGENT ALARM

a. Description. The M24A1 and the M24 G-agent alarm spare parts kits contain approximately 287 spare parts each to be used in making major repairs to the M6A1 and the M6 G-agent alarms.

b. Use. These kits contain spare parts for the M6A1 and the M6 automatic field G-agent alarms.

c. Effectiveness. The spare parts kit provides the necessary spare parts for five M6 or M6A1 operating alarms for a period of one year.

d. Shipment. The spare parts are packaged in a fiberboard box that weighs 135 lb and occupies 14.0 cu ft. For the list of items, refer to the instruction manual that is provided with the alarm.

e. Reference Publications.

Alarm, Field, G-Agents, M--(E21), TM 3-351, Department of the Army.

Instruction Book for Alarm, Field, Automatic, E21R2, Department of the Army, Chemical Corps, EP-14-R2.

A22. TRANSFORMER-RECTIFIER UNIT, M2

a. Description. The M2 transformer-rectifier unit is housed in an aluminum case that is 11-3/16 in. by 9 in. by 6-1/8 in. The unpacked unit weighs 13 lb. It is designed to provide 24 volts of direct current from any 115-volt, 60-cycle alternating current line. The unit is provided instead of a 24-volt dc battery or two 12-volt batteries.

b. Use. The M2 transformer-rectifier unit is a portable power supply for the M6A1 or M6 automatic G-agent alarm.

c. Effectiveness. The M2 transformer-rectifier provides a 24-volt power supply for the automatic G-agent alarms.

d. Limitations. The M2 transformer-rectifier has the following limitations.

(1) A 115-volt ac power source must be available.

(2) Where power is not available, 24-volt dc batteries must be used.

e. Shipment. Each M2 unit is packed in a fiberboard carton and shipped in a wooden box that is 20 in. long, 10 in. high, and 13 in. wide, weighs 31 lb, and occupies 1.6 cu ft.

f. Reference Publications.

Instruction Book for Alarm, Field, Automatic, (E21R2), EP-14-R2, April 1958.

Instruction Book for Alarm, Field, Automatic, E21, (M6), EP-14, March 1955.

A23. WATER TESTING KIT, CHEMICAL AGENTS, SCREENING, M2

a. Description. Each M2 water testing kit (Figure A-23) contains equipment and materials for testing 15 samples of water. The reagents and equipment are packed in a pocket-sized, transparent plastic container that is about 6 in. by 3-1/2 in. by 2-1/2 in. The kit contains two test tubes, a chlorine demand assembly, a bottle and tube for the detection of arsenicals by a modified Gutzeit method (this bottle is also used in the nerve gas detection test), and nine vials that contain reagents and test papers. A test tube brush and a pipe cleaner are provided for cleaning the apparatus. The kit contains four reagent chemicals that are packaged in screw-cap vials, a graduated medicine dropper, and two aluminum measuring scoops.

b. Use. The M2 kit is designed for reconnaissance use. It is used to screen out sources of water that are so contaminated that they can not be rendered potable by the customary field methods, such as chlorination in the lyster bag. Negative tests indicate that the water is suitable for chlorination or iodination and that it may be used by personnel within the limits outlined below. If any of the tests are positive, the water should not be used until a more complete analysis can be made.

c. Application and Effectiveness. The booklets that are issued with the M2 testing kit give specific directions for each test. The directions must be followed exactly. The tests give the following effective results.

(1) Arsenicals are converted to arsines by hydrogen, which is produced by the action of sodium acid sulfate on zinc. The arsines react with a sensitized paper to produce a stain. This test is sensitive to 5 ppm.

(2) The indicator paper determines the pH.

(3) The kit can test for mustards as low as 5 ppm of unhydrolyzed sulfur mustard. This mustard test also indicates the presence of cyanogen chloride by a change in the color of the reagent to yellow.

(4) The chlorine demand is determined by means of halazone tablets and an orthotolidine testing assembly. This test detects the presence of other agents, such as the cyanides, for which a test is not specifically made.

(5) The nerve gases are detected by a color reaction. One-half ppm of unhydrolyzed nerve gas can be detected.

(6) If no evidence of contamination is found, the odor and taste of the water can be safely tested.

d. Limitations. The M2 water testing kit has the following limitations.

(1) The kit is designed for use only on raw (untreated) water because the chemicals used in water treatment invalidates the interpretations.

(2) Individuals who perform the tests must have normal color vision.

(3) The tests will not detect traces of toxic agents that are harmless when the water is used for short periods of time. When arsenic is detected, even though the water has been passed as safe by the kit, the water should not be used for drinking or cooking purposes for any period that exceeds one week because of the possible cumulative effects.

(4) Water may give a negative test for nitrogen mustards and still produce symptoms if it is consumed in large quantities; therefore the water should not be used without special purification if even the faintest blue color develops in the test for mustards.

(5) A false positive result for the nerve gas test may be obtained if an appreciable quantity of ferrous iron is present in the water. Large quantities of reducing agents, such as hydrolyzed mustard (H), will lessen the intensity of the color.

Figure A-23. Water Testing Kit, Chemical Warfare Agents, Screening, M2

(6) The tests that are provided by the kit are not quantitative and therefore will not serve as a guide for the purification of field water supplies. More elaborate methods are provided by the M4 water testing kit for poisons to be used by the water-supply units.

e. Shipment. The M2 water testing kits are packaged individually in a fiberboard box. Twenty-four packaged kits are shipped in a wooden box that weighs about 50 lb and occupies 1.0 cu.ft.

f. Reference Publications.

Treatment of Chemical Warfare Casualties, NAVMED P-5041, 1956, Department of the Navy.

Water Testing and Screening Kit, AN-M2, Army Technical Bulletin TP CML 40, 1955.

A24. WATER TESTING KIT, POISONS, M4

a. Description. The M4 water testing kit for poisons (Figure A-24) is a small, portable laboratory. It is packed in a metal chest that is 31-1/2 in. by 19-1/2 in. by 6 in. and weighs 55 lb when fully supplied.

b. Use. The M4 kit is used to identify the CW agent in a suspected water source and to determine the amount of the agent that is present.

c. Application. This kit requires the use of elaborate methods and the services of trained medical personnel to detect the presence of the CW agent. Quantitative determinations can be made of chlorine demand, mustards, arsenicals, cyanides, and pH. As far as possible, standard tests are employed with little or no modification. These tests include (a) the identification of the CW contaminants, (b) the quantities of the CW contaminants that are present, (c) the feasibility of purification of the water, (d) the methods to be employed in the treatment of the water, and (e) the quantities of the chemicals that are required for adequate treatment.

d. Limitations. The M4 water testing kit has the following limitations.

(1) The tests that are made with this kit are specific for active toxic agents, but they will not detect the nontoxic hydrolysis products of these agents.

(2) All tests must be made under rigidly controlled conditions by a trained technician, following explicit instructions for testing and making interpretations.

e. Shipment. One kit is packed in each chest, which weighs about 55 lb and occupies 4.3 cu ft.

f. Reference Publication.

Treatment of Chemical Warfare Casualties, NAVMED P-5041, Department of the Navy, 1956.

Figure A-24. Water Testing Kit, Poisons, M4

PERSONNEL PROTECTION

Items	28 - 67
Paragraphs	A25 - A39

A25. BAG, WATERPROOFING, M1, FOR M9A1 MASK

a. Description. The M1 waterproofing bag (Figure A-25) is 19 in. by 13 in. and is made of polyvinyl chloride film. It folds to a 4-1/2 in. by 2-1/2 in. size for insertion in a 5 in. by 6 in. polyethylene carrying pouch. A small separate pouch contains three rubber bands that are used to seal the waterproofing bag after the mask has been inserted.

b. Use. The M1 protective mask waterproofing bag is used to keep the M9A1 mask dry during an amphibious operation or any other known exposure to water. One bag is issued to each individual and is carried in a pocket at the bottom of the mask carrier.

c. Application. The protective mask is removed from the carrier and placed in the waterproofing bag in accordance with instructions that are printed on the bag. Because of the possibility that the bag may have to be reused in combat, the used bag should be folded and returned to the carrier for later use.

d. Effectiveness. The M1 waterproofing bag keeps the protective mask dry.

e. Limitations. The M1 waterproofing bag has the following limitations.

(1) The mask should not be stored in the bag for more than 24 hours.

(2) The bag should not be placed in contact with foodstuffs because of its toxic effects.

(3) The pointed ends of gear may make holes in the bag.

f. Shipment. Two hundred and fifty bags are packaged in a wooden box that weighs 50 lb and occupies 1.5 cu ft.

g. Reference Publications.

Mask, Protective, Field, M9, and Mask, Protective, Field, M9A1, TM 3-522-15, Department of the Army.

Protective Masks and Accessories, TM 3-205, Department of the Army.

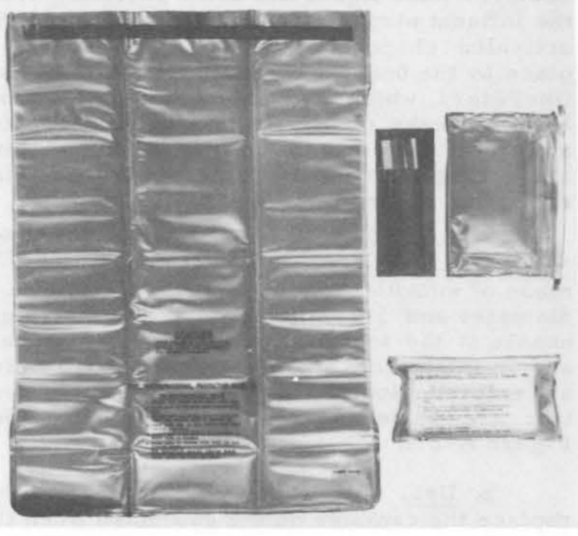


Figure A-25. Bag, Waterproofing, M1, for M9A1 Mask

A26. CANISTER, SPARE, FOR PROTECTIVE MASKS

a. Description.

1. M11 Spare Canister for M9A1 Mask. The M11 canister is made of sheet aluminum alloy or sheet steel, is cylindrical in shape, 4-1/2 in. in diameter and 2 in. thick, and painted dark gray. A metal closure cap and a rubber plug are provided to waterproof the canister when it is not in use. Each canister is sealed in a metal container that is similar to a coffee can with a key. The canister consists of a gas (chemical) filter and a particulate (aerosol) filter that are housed in a metal body. The particulate filter is made of fluted, or folded, asbestos-bearing paper that removes toxic liquid and solid particles from the influent air; the gas filter consists of ASC activated charcoal. The charcoal is held in place by the body of the canister between two fine filters, which consist of felted cotton cloth between disks of plastic netting. Perforated metal disks protect the felting. The canisters are packaged in hermetically sealed containers. (See Figure A-26.)

2. M10A1 Spare Canister for LWS M3A1-10A1-6 Mask. The M10A1 canister is made of smooth sheet steel that is 3-1/4 in. in diameter and 5-1/2 in. long. It has a straight nozzle at the top, to which a hose is attached, and an inlet valve at the bottom, through which air enters. Most units now in the supply system are sealed in metal containers. (See Figure A-27.)

b. Use. The spare canister is used to replace the canister on the gas mask when the existing canister is considered unsafe after it has been exposed to CW agents.

c. Application. The M11 canister is replaced simply by unscrewing the old canister and attaching a new one to the M9A1 mask. To replace the M10A1 canister on the LWS mask an LWS mask repair kit should be used by authorized personnel in the following manner. Remove the wire clamp and tape from the hose, insert the straight nozzle of the canister into the hose, and apply 1-1/4 turns of adhesive tape over the hose. Use the wire clamp over the adhesive tape and securely bind the hose to the nozzle.

d. Effectiveness. The canister offers protection against all toxicological agents.

e. Limitations. These canisters have the following limitations, which are also included as limitations of the protective mask.

(1) Oxygen Supply. Mask canisters only purify air; they do not manufacture oxygen. Therefore, when air is deficient in oxygen, no canister is effective in supplying air that is suitable for breathing.

(2) Ineffective under Certain Conditions. Military canisters are not for firefighting use, neither do they protect against carbon monoxide gases. They are designed for concentrations that are not greater than one percent by volume, and they do not provide extended protection against the high concentrations of war gases that may result from spillage or explosion in enclosed places.

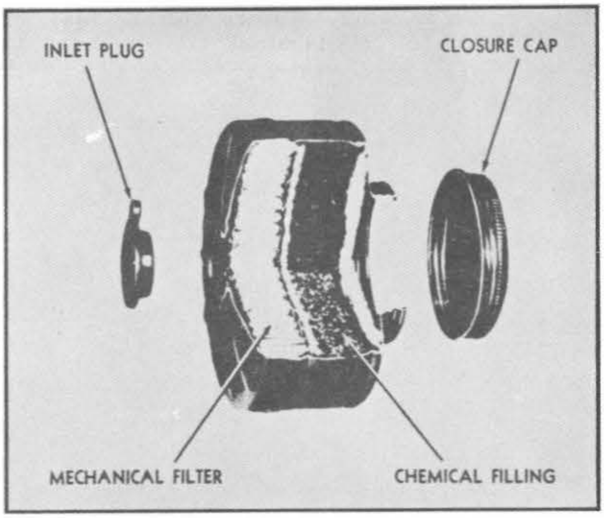


Figure A-26. Canister, Spare, M11, for M9A1 Mask

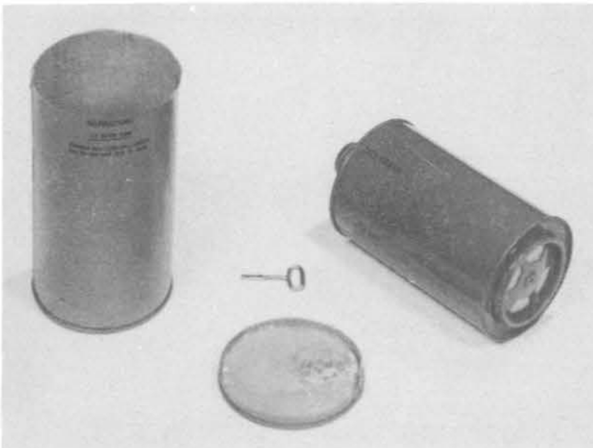


Figure A-27. Canister, Spare, M10A1, for LWS Mask

(3) Life Expectancy of Canisters. The effective life of any individual canister varies with the type and concentration of the agent in the air, the number of minutes of exposure to the concentration, and the rate of breathing of the wearer. The military canister rarely breaks down suddenly. Usually it fails gradually and the wearer is warned of the need for replacement by minor sensory effects, such as a slight but persistent odor of gas, persistent lacrimation, or failing sight. However, when canisters are exposed to heavy concentrations of CW agents from 15 to 50 minutes, they should be replaced after each exposure.

f. Shipment. The two types of canisters are shipped in the following manner.

(1) Eighteen M11 canisters are packaged in a wooden box that weighs 46 lb and occupies 1.6 cu ft.

(2) Eighteen M10A1 canisters are packaged in a wooden box that weighs 44 lb and occupies 1.3 cu ft.

g. Reference Publications.

Protective Masks and Accessories, TM 3-205, Department of the Army.

Mask, Protective, Field, M9, and Mask, Protective, Field, M9A1, TM 3-522-15, Department of the Army.

A27. COVER, PROTECTIVE, INDIVIDUAL

a. Description. The individual protective cover (Figure A-28) is an envelope of impermeable material with a transparent head section. The wrapper for the cover has a tear-tape device to provide a positive and quick opening.

b. Use. The cover is used to protect the head and body against sprays of chemical agents. The cover is also used as a bag to hold contaminated clothing either while a person is awaiting decontamination or, in the case of BW contamination, during decontamination with ethylene oxide.

c. Application. The cover, which is usually carried in a gas mask carrier, is taken out of the wrapper, opened, and thrown over the head; or clothing that is contaminated with BW agents is placed in a bag with ETO dispenser.

d. Effectiveness. The cover will provide protection against liquid blister gas for a period of several hours.

e. Limitations. The individual protective cover has the following limitations.

(1) The cover will not protect against vapors of blister gas.

(2) Newer covers, wrapped in aluminum foil, will not offer protection below 0° F.

(3) The present cellophane-wrapped covers will not offer protection below 32° F.

f. Shipment. The covers are packed with 100 in a wooden box that weighs 83 lb and occupies 2.1 cu ft.

Figure A-28. Cover, Protective, Individual

A28. HOOD, GAS MASK, TOXICOLOGICAL AGENTS, PROTECTIVE, M4

a. Description. The M4 protective hood (Figure A-29) is made of butyl-rubber-coated cloth with adjustable openings. It completely covers the head and neck of the wearer and has fasteners to keep the hood down on the wearer's shoulders.

b. Use. This hood is used in conjunction with other clothing when a person is engaged in performing BW decontamination work or other operations that involve danger from spillage or splashes in handling large quantities of liquid chemical agents.

c. Application. The protective hood should be fitted to the mask prior to donning the mask, and it is the last item of clothing to be donned.

d. Effectiveness. The hood is resistant to chemical agent vapors and provides adequate protection against biological agents and keeps radioactive dust off the head and neck. Because drops of CW contaminants that may fall on the hood may possibly penetrate the cloth, the contaminant should be either neutralized or removed from the hood as soon as possible.

e. Limitation. One limitation of the M4 protective hood is that it can only be used with the M9A1 and LWS protective masks.

f. Shipment. Sixty hoods are packed and shipped in a wooden box that weighs 60 lb and occupies 2.6 cu ft.

g. Reference Publication.

Protective Masks and Accessories, TM 3-205, Department of the Army.

Figure A-29. Hood, Gas Mask, Toxicological Agents, Protective, M4

A29. IMPERMEABLE PROTECTIVE CLOTHING OUTFIT, M3

a. Description. The M3 impermeable protective clothing outfit (Figure A-30) is made of cloth that is coated on both sides with butyl rubber, which does not allow the passage of air through the fabric. The outfit includes the following items.

Boots, knee, rubber
Cover, boot, protective
Cover, cooling, hood, gas mask
Coveralls, protective, one-piece
Gloves, protective
Hood, protective mask
Suit, cooling, two-piece

b. Use. Impermeable clothing is intended primarily for the protection of military personnel who are engaged in extremely hazardous decontamination work or in other operations that involve danger from the spilling or splashing of liquid chemical agents.

c. Application. The personnel to whom this clothing is issued are those who work in toxic plants and with toxic munitions and those who are engaged in the decontamination of heavily contaminated areas. The material of the protective clothing outfit is resistant to liquid chemical agents and it also provides adequate protection against biological agents.

d. Limitations. The impermeable protective clothing outfit has the following limitations.

(1) Although the protective outfit is resistant to liquid chemical agents, the liquid may penetrate the impermeable clothing; therefore, the liquid contaminant should be either neutralized or removed from the clothing as quickly as possible.

(2) This clothing may be worn for a limited time only. (See paragraph 4B1.05.)

e. Shipment. Because of the limited number of outfits that may be required at any activity, each item will be packaged individually and may be ordered individually.

f. Reference Publications.

Protective Clothing and Accessories, TM 3-304, Department of the Army, 1957.

Decontamination, TM 3-220, Department of the Army, 1953.

Figure A-30. Impermeable Protective Clothing Outfit, M3

A30. IMPREGNATING SET, CLOTHING, FIELD, M3, and IMPREGNATING OUTFIT, CLOTHING, FIELD, M1

a. Description.

1. The M3 Set. The M3 field clothing impregnating set contains a 16.5-pound container of impregnite (XXCC3), a 4.3-pound container of chlorinated paraffin (a binder), a 1.7-pound can of wetting compound, and a 1.0-pound can of dye mix. (See Figure 4-5.)

2. The M1 Outfit. The M1 field impregnating outfit consists of 4 containers of chemicals, one mixing bag with staves, one paddle, one clothesline rope, and one instruction card. The chemical containers are numbered consecutively from 1 through 4 for identification purposes.

b. Use. The M3 set and the M1 outfit are designed for field impregnation or reimpregnation of permeable protective clothing. Ordinary issue clothing may be impregnated to increase resistance to blister agents.

c. Application. The materials that are contained in the outfit or set are mixed in suitable containers in accordance with the instruction in the box. A suitable site should be selected, either indoors or outdoors, but it must be large enough to dry 20 to 25 sets of clothing; and if the space is outdoors, it must be in the shade. Because constant mixing of the materials is necessary, three men are required. The clothing is soaked and kneaded in the solution until all parts are wetted, then they are wrung out lightly and hung up to dry.

d. Effectiveness. The mix in the M3 set will make sufficient solution for impregnating 20 to 25 sets of clothing, and it will be as effective as clothing that is treated in a fixed plant. The mix in the M1 outfit will make sufficient solution for impregnating approximately 30 to 38 sets of clothing.

e. Limitations. The limitations of the M3 set and the M1 outfit are as follows.

(1) The mix may not be used in temperatures below 32° F.

(2) Continual stirring of the solution is required.

(3) Direct sunlight hastens decomposition of the impregnite.

(4) The impregnite that is applied from the outfit or set washes out when the clothing is laundered.

f. Shipment. Components of the M3 set are packed in a wooden box that weighs approximately 53 lb and occupies 1.7 cu ft. Components of the M1 outfit are packed in a wooden box that weighs approximately 72 lb and occupies 2.9 cu ft.

g. Reference Publication.

Impregnating Set, Clothing, Field, M3; Impregnating Outfit, Clothing, Field, M1; Kit, Testing, Impregnite-in-Clothing, M1, TM 3-303, Department of the Army.

A31. ISOPROPYL ALCOHOL, NF, 5-GAL

a. Description. NF isopropyl alcohol is ordinary rubbing alcohol.

b. Use. Alcohol is used to decontaminate personnel who have been exposed to BW agents when showering facilities (soap and water) are not available.

c. Application. Isopropyl alcohol is used for a complete rubdown of the body and for treatment of the hair.

d. Effectiveness. Alcohol is effective for most BW agents.

e. Limitation. One limitation of alcohol is that it is not generally as effective as showers with soap and water.

f. Shipment. Alcohol is shipped in a 5-gal can that weighs 39 lb and occupies 1.0 cu ft.

A32. LEATHER DRESSING, VESICANT GAS-RESISTANT

a. Description. The gas-resistant vesicant leather dressing is a mixture of animal oil (similar to neat's-foot oil), ester gum, paraffin wax, microcrystalline petroleum wax, Stoddard solvent, and aluminum stearate.

b. Use. Gas-resistant vesicant leather dressing is used for the rapid treatment of leather shoes as a prevention against liquid vesicant agents.

c. Application. This dressing is applied by hand-rubbing at temperatures above 20° F.

d. Effectiveness. Gas-resistant vesicant leather dressing will resist liquid mustard for a period of approximately 2-1/2 hr.

e. Limitation. One limitation of the leather dressing is that it is difficult to apply it in temperatures below 20° F.

f. Shipment. The M1 leather dressing is shipped in 50 eight-oz cans in a wooden box that weighs 63 lb and occupies 3.4 cu ft. The M2 leather dressing is shipped in 96 four-oz cans in a wooden box that weighs 43 lb and occupies 1.1 cu ft.

g. Reference Publication.

Individual Protective and Detection Equipment, TM 3-290, Department of the Army.

A33. MASK, PROTECTIVE, FIELD

a. Description.

1. M9A1, Field Protective Mask. The M9A1 mask is one of the two masks that are supplied for use ashore. It consists of a facepiece with a canister attached to either the right or left side. The mask is issued to personnel complete with the carrier and antidim. This mask is available in large, medium, and small sizes with a choice of the left- or right-cheek-mounted canisters. Each mask is hermetically sealed in a metal container. (See Figure A-31.)

2. M3A1-10A1-6 Lightweight Service Mask. The LWS mask consists of a facepiece and a cylindrical canister that is connected to the facepiece by a hose. This mask also is issued to personnel complete with the carrier and antidim. This mask is available in the universal and small sizes. (See Figure A-32.) All LWS masks in supply systems are no longer considered satisfactory. Directives are currently being issued to survey all existing LWS masks and associated accessories. M9A1 masks are being issued as available to meet requirements. The accessories being deleted include the M10A1 spare canister repair kit for LWS M3A1-10A1 mask and the waterproofing set, C3.

b. Use. These two masks are used to protect the wearers by purifying the air that is suspected to be contaminated with ABC agents.

c. Application. Protective masks must be donned when the possibility of an ABC attack is suspected. Masks must not be removed until tests have proved that there is no contamination present. These masks provide efficient inhalation protection against hazards of all ABC warfare agents.

d. Limitations. The M9A1 and the LWS masks have the following limitations.

(1) Leakage. Because of the variation in the size and shape of individual faces, some leakage may be expected around the edges of the facepiece of a mask. This leakage does not seriously affect the protection given against some CW agents, but it may critically affect the protection against BW agents. Therefore, an additional hood is required to protect personnel, such as decontamination crews, who are exposed for long periods of time.

(2) Eyeglasses. Ordinary eyeglasses can not be used with the M9A1 and the M3A1-10A1-6 masks. The Bureau of Medicine and Surgery is planning to provide the individual who requires eyeglasses with special spectacles that will snap on the interior of the mask eye lens.

(3) Oxygen Supply. Mask canisters only purify air; they do not manufacture oxygen. Therefore, when air is deficient in oxygen, no canister is effective in supplying air that is suitable for breathing.

(4) Ineffective Under Certain Conditions. Military canisters are not for fire-fighting use, neither do they protect against carbon monoxide gases. They are designed for concentrations that are not greater than one percent by volume, and they do not provide

Figure A-31. Mask, Protective, Field, M9A1

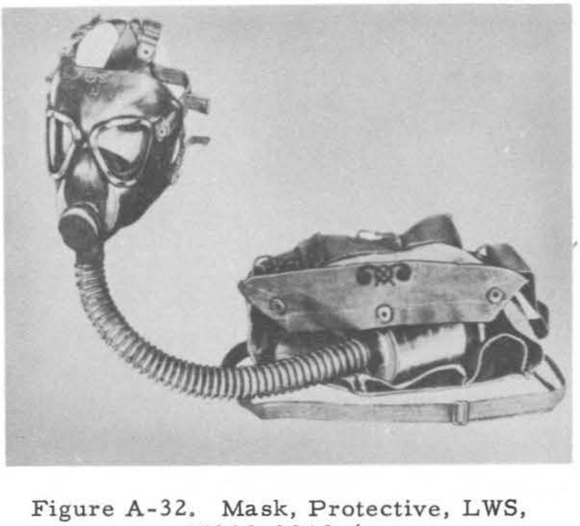


Figure A-32. Mask, Protective, LWS, M3A1-10A1-6

extended protection against the high concentrations of war gases that may result from spillage or explosion in enclosed places.

(5) Life Expectancy of Canisters. The effective life of any individual canister varies with the type and concentration of the agent in the air, the number of minutes of exposure to the concentration, and the rate of breathing of the wearer. The military canister rarely breaks down suddenly. Usually it fails gradually and the wearer is warned of the need for replacement by minor sensory effects, such as a slight but persistent odor of gas, persistent lacrimation, or failing sight. However, when canisters are exposed to heavy concentrations of CW agents from 15 to 50 minutes, they should be replaced after each exposure.

e. Shipment. The two types of masks are shipped in the following manner.

(1) One M9A1 protective mask is packed in a sealed metal container, and six containers are packaged in a wooden box that weighs 55 lb and occupies 3.3 cu ft.

(2) Six LWS masks (M3A1-10A1-6) are packed in a wooden box that weighs 56 lb and occupies 3.3 cu ft.

f. Distribution By Size. The normal distribution of protective masks by size is shown in table:

M9A1 Field Protective Mask

Mask size	Canister mounting	Normal Issue (%)
Large	Left	5
Large	Right	1
Medium	Left	63
Medium	Right	5
Small	Left	24
Small	Right	2

M3A1-10A1-6 LWS Mask

Mask size	Canister mounting	Normal Issue (%)
Small		5
Universal		95

g. Reference Publications.

Protective Masks and Accessories, TM 3-205, Department of the Army.

Mask, Protective, Field, M9, and Mask, Protective, Field, M9A1, TM 3-522-15, Department of the Army.

h. Mask, Protective, Field, New M17.

(1) The M17 mask has been developed as a replacement for the M9A1. It was developed to provide a very high order of respiratory protection against all CW agents and to obtain better speech transmission, vision, compactness, wearability, and comfort.

(2) The final engineering tests show that this mask meets the design criteria in most respects. It has greater wearer acceptance because it is more comfortable and has reduced inhalation breathing resistance. Better vision is obtained in the field and it has considerable gain in speech intelligibility over the M9A1. It also fits better, is easier to put on, and is less susceptible to damage than is the M9A1 mask.

(3) The M17 mask provides adequate protection against simulated V-aerosols and GB agents. Improvements are being made to obtain better protection against some of the other agents. One disadvantage appears to be that it requires from 3 to 5 minutes for a trained man to change the filter elements.

(4) It is anticipated that this M17 mask will be standardized in the near future.

A34. PERMEABLE PROTECTIVE CLOTHING

a. Description. The permeable protective clothing outfit (Figure A-33) consists of an undershirt, drawers, socks, cotton gloves, cotton trousers, and a special jumper. These articles must be impregnated with a chemical to neutralize CW vapors and fine sprays to prevent the contaminant from reaching the skin. These outfits are available in three sizes--large, medium, and small.

b. Use. This protective outfit is primarily for use by teams of the disaster control organization when they are working in areas that are contaminated with blister agents.

c. Effectiveness. This outfit is effective against vapors and fine sprays of blister agents and all BW agents. Additional protection may be provided by the use of standard knee-length rubber boots and by the use of rubber gloves over the cotton gloves that are provided.

d. Limitations. The protective clothing outfit has the following limitations.

(1) It is not effective against liquids and droplets of blister agents; neither is it a protection against nerve gas or gamma radiation.

(2) It is uncomfortable after prolonged wearing.

(3) The impregnating treatment tends to deteriorate in storage and after prolonged exposure to bright sunlight.

e. Shipment. Ten complete outfits are packaged in a fiberboard container. Individual items are available and are listed in the standard stock catalog as follows.

(1) Parka, men's, chemical warfare defense.

(2) Trousers, men's, chemical warfare defense.

(3) Socks, men's, chemical warfare defense.

f. Reference Publication.

Protective Clothing and Accessories, TM 3-304, Department of the Army.

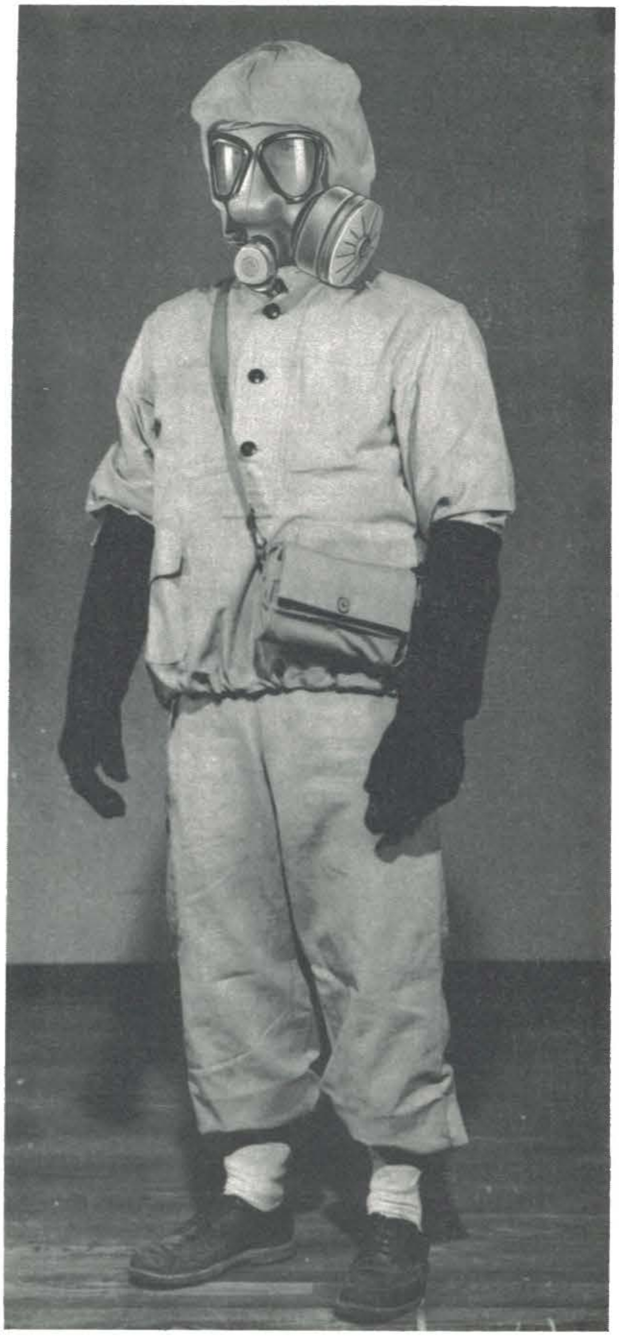


Figure A-33. Permeable Protective Clothing

A35. PROTECTION AND TREATMENT SET, CHEMICAL AGENTS, M5A1

a. Description. The M5A1 kit (Figure A-34) consists of a waterproof metal container, 3 tubes of M5 protective ointment, 1 tube of BAL eye ointment, and 1 atropine tartrate injection. The container is about 4 in. by 3-1/2 in. by 1 in. It is waterproofed, and the lid is held tightly in place by a metal clip. Directions for the use of the kit are lithographed on the container.

b. Use. This set is provided to furnish the necessary material for first-aid and self-aid treatment that might be required after a CW attack.

c. Application. The atropine injection is provided to treat persons who are suffering from the effects of G-agents. The BAL ointment is provided to counteract the effect of Lewisite in the eyes. The M5 protective ointment provides treatment or emergency decontamination of skin areas that are exposed to blister agents. This ointment may be applied either before or after exposure.

d. Limitation. One limitation of the M5A1 set is that extreme care must be exercised in the use of the atropine injection.

e. Shipment. Seventy M5A1 units are packed in a wooden box that weighs 50 lb and occupies 1.4 cu ft.

f. Reference Publication.

Treatment of Chemical Warfare Casualties, NAVMED P-5041, Department of the Navy.

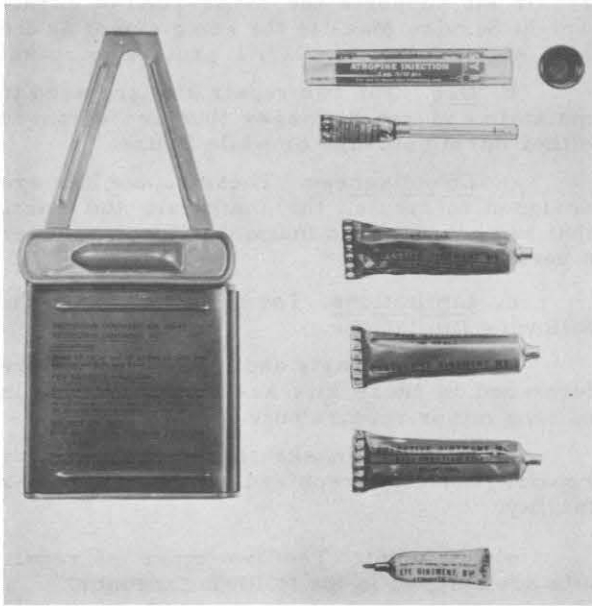


Figure A-34. Protection and Treatment Set, Chemical Agents, M5A1

A36. REPAIR KIT, FIELD, M19, FOR M9A1 PROTECTIVE MASK

a. Description. The M19 repair kit (Figure A-35) supports the M9A1 protective mask. It contains replacement lenses, head harness straps and snaps, replacement outlet valves, tools, rubber cement, and other miscellaneous material. The LWS gas mask repair kit supports the M3A1-10A1-6 Lightweight Service Mask to the same extent as the M19 kit supports the M9A1 protective mask.

b. Use. The two repair kits are used to maintain and repair masks that are damaged either during storage or while in use.

c. Effectiveness. These repair kits are designed to furnish the materials and parts that are necessary to maintain 1,000 masks for a period of one year.

d. Limitations. The repair kits have the following limitations.

(1) The parts and equipment that are furnished in these kits are limited to use in making minor repairs only.

(2) The masks that require major repairs must be repaired at a mask repair facility.

e. Shipment. The two types of repair kits are shipped in the following manner.

(1) The M19 kit is packaged in a fiberboard box that weighs about 41 lb and occupies 1.3 cu ft.

(2) The LWS kit is packaged in a wooden box that weighs about 60 lb and occupies 2.6 cu ft.

f. Reference Publication.

Protective Masks and Accessories, TM 3-205, Department of the Army.

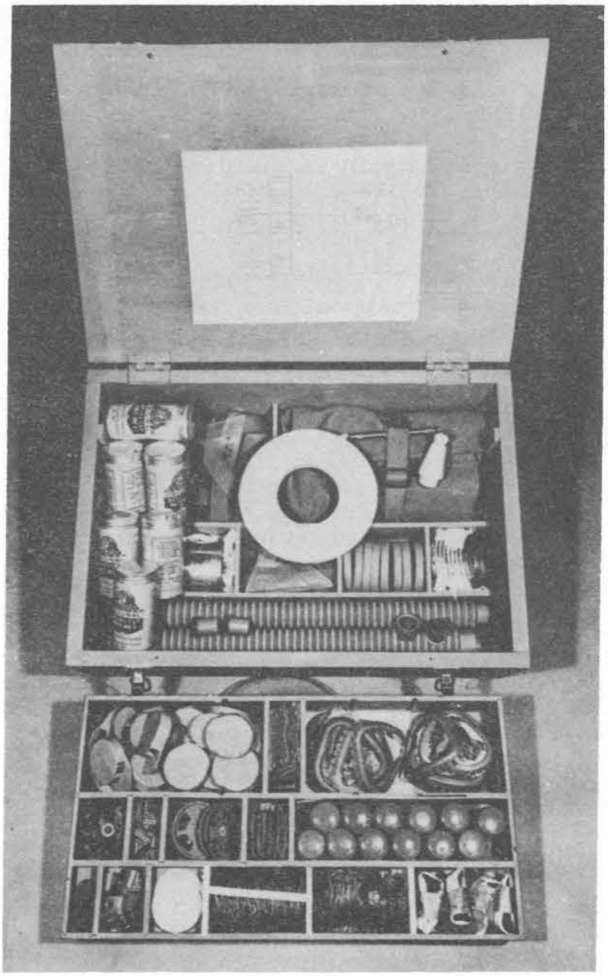


Figure A-35. Repair Kit, Field, M19, for M9A1 Protective Mask

A37. SOAP, SURGICAL, 4-OUNCE, WITH HEXACHLOROPHENE

a. Description. The surgical soap with hexachlorophene is similar to commercial surgical soap.

b. Use. Surgical soap is used for the decontamination of personnel who have been exposed to BW agents.

c. Application. Soap should be used and rinsed off with warm water. The process should be repeated several times.

d. Effectiveness. The effectiveness of the soap depends on the thoroughness of the showering.

e. Limitation. One limitation in the use of surgical soap is that warm water showers are required.

f. Shipment. Twenty-four cartons, each containing 12 bars of soap, are packed in a wooden box that weighs 125 lb and occupies 9.0 cu ft.

A38. WATER-PURIFICATION TABLET, IODINE

a. Description. The iodine water tablet is solid in form and is packed with 50 tablets in a bottle.

b. Use. Water-purification tablets are used to decontaminate water in extremely small containers, such as canteens, that are suspected of being contaminated by BW agents.

c. Application. Water should be boiled for 10 minutes, if possible, and decontaminated with 3 tablets of iodine to a quart of water. The directions on the bottle that specify one tablet to a quart of water are not applicable.

d. Effectiveness. Iodine tablets will make water potable against BW agents after the water is boiled for 10 minutes or longer.

e. Limitations. The water-purification tablets have the following limitations.

(1) A cut-and-try procedure is necessary to effect decontamination.

(2) A waiting period of approximately an hour may be necessary before the water is ready for consumption, depending upon the degree of contamination.

f. Shipment. Four hundred bottles, each containing 50 iodine tablets, are packed in a carton that weighs 41 lb and occupies 1 cu ft.

A39. WATERPROOFING SET, C3, FOR LWS MASK, M3A1-10A1-6

a. Description. The C3 waterproofing set (Figure A-36) consists of a metal clamp for the hose, a rubber cap for the canister inlet valve, and an instruction card. These items are tied to the canister nozzle by a cord and are issued as required.

b. Use. The waterproofing set is provided to keep the canister dry and also to seal the M10A1 canister when the LWS masks are being decontaminated with the ETO Freon dispenser.

c. Application. The instructions on the card should be followed to waterproof or seal the canister. The hose clamp must not be left on the hose except when it is needed for waterproofing or decontaminating. To dry the mask, the hose clamp and rubber cap should be left in position and the mask should be hung up to allow water to drain out of the hose and facepiece until the mask is dry. If the mask must be donned when it is wet, all water should be shaken from the mask and carrier and/or the facepiece should be wiped dry before the waterproofing equipment is removed.

d. Effectiveness. The waterproofing set prevents water from entering the canister even during an amphibious operation. It also seals the mask canister when it is being decontaminated with the ETO Freon dispenser in a gas-proof bag.

e. Limitation. One limitation of the waterproofing set is that the rubber cap must be pressed firmly over the canister rim to prevent dislodgment.

f. Shipment. Two hundred waterproofing sets are packaged in a wooden box that weighs about 75 lb and occupies 2.6 cu ft.

g. Reference Publication.

Protective Masks and Accessories, TM 3-205, 1955, including Changes 1 through 4, Department of the Army.

Figure A-36. Waterproofing Set, C3, for LWS Mask

GROUP PROTECTION

Items	68 - 78
Paragraphs	A40 - A49

A40. AIR LOCK, PORTABLE

a. Description. The portable air lock (Figure A-37) is a chamber that is constructed in the field in accordance with Yards and Docks drawings Nos. 575,412; 575,413, 566,814; 566,815, and 566,816. It is about 12 ft by 4 ft by 8 ft, has three 4-ft compartments, and has a 1-1/2-ft accordion canvas appendage that can be attached securely (airtight) to the building. It is constructed of wood and canvas. It has two air regulators and two clothes chutes between the inner and outer compartments, as well as an antibackdraft valve that is installed in the outer compartment.

b. Use. The air lock is used primarily to prevent excessive loss of inside pressure when personnel enter or leave a pressurized area. It is also used as an area in which personnel can discard contaminated clothing and undress before showering.

c. Application. The portable air lock is placed into position and the edges are sealed against the existing building with canvas when a shelter becomes operational.

d. Effectiveness. Because the air lock is at a lower positive pressure than the inner rooms are, it will effectively cause the contaminated air to be blown out into the atmosphere. However, it must be considered as a contaminated area, and personnel are required to keep their protective masks on in the outer air lock.

e. Limitation. One limitation of the portable air lock is that it can be installed in place only where protected areas are pressurized.

f. Reference Publication.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

Figure A-37. Air Lock, Portable

A41. CLOSURE, PROTECTIVE SHELTER, ANTIBLAST, M1

a. Description. The M1 antiblast closure (Figure A-38) is a pressure-actuated device for shutting off blast pressures from protective shelters and filter units.

b. Use. The M1 closure is used to protect personnel, equipment, and filter units from extreme or sudden pressures into the intake or the exhaust outlets of a pressurized structure as a result of blasts.

c. Application. The M1 antiblast closure is designed for installation in the air intake or exhaust outlets of a building that requires blast protection. Suitable piping extends from the inlet to the atmosphere outside the shelter. When sudden and extreme pressures develop outside the shelter, the disc is forced against the perforated portion of the body, thereby shutting off the blast pressure into the shelter.

d. Effectiveness. The M1 closure is capable of providing protection against blast pressures of at least 20 psi. The closure, which is activated by the blast, will close rapidly enough to prevent damaging blast pressures from entering the structure.

e. Limitations. The M1 closure has the following limitations.

(1) The closure is designed for use with an M6 300-cfm filter unit.

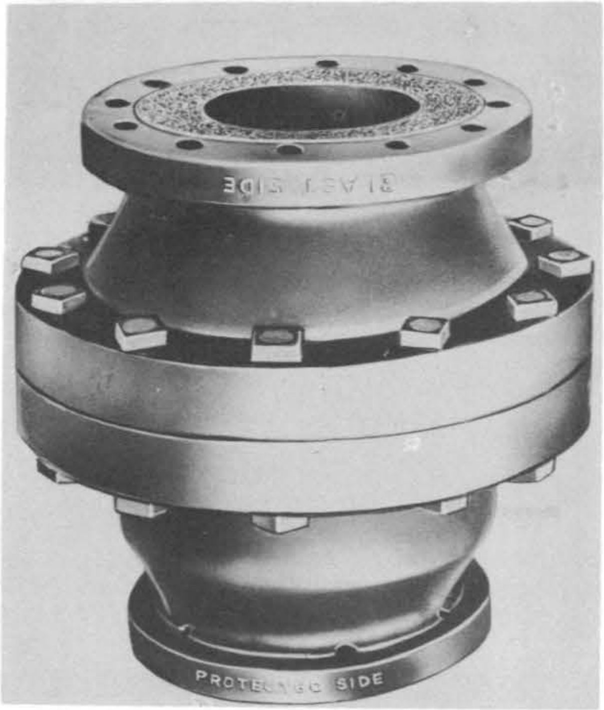
(2) Two such units must be connected in parallel to provide 600 cfm of air for the M9 filter unit.

f. Shipment. The M1 unit is packaged in a wooden crate that weighs about 330 lb and occupies 5.6 cu ft.

g. Reference Publication.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

NOTE: Other sizes of blast closure devices are being developed. When they are available, notice will be given by appropriate changes to this publication.



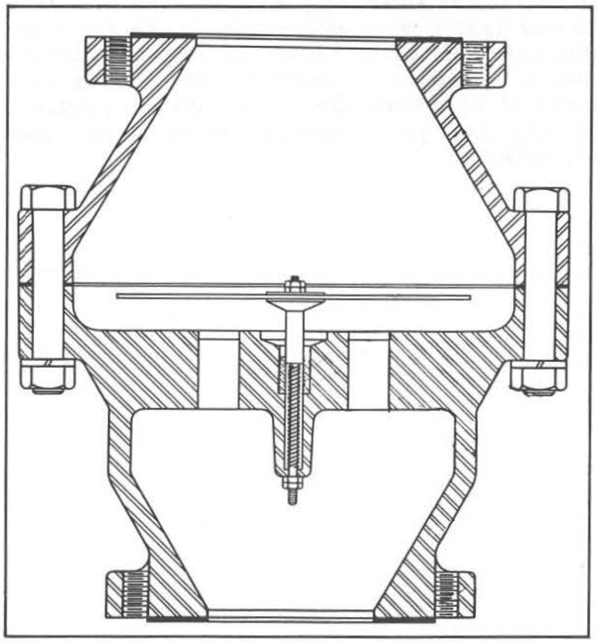


Figure A-38. Closure, Protective Shelter, Antiblast, M1

A42. FILTER, GAS, 150-CFM, M10, FOR M6 FILTER UNIT

a. Description. The M10 air filter panel (Figure A-39) consists of an aluminum frame that contains charcoal filtering media. These units are for replacement in the filters in the 300-cfm filter unit. Two M10 filters are required for each M6 unit. The size of the M10 filter is 24 in. by 24 in. by 2-11/16 in.

b. Use. The M10 gas filter is used to replace filters in the M6 filter unit.

c. Application. The M10 filter is a component of the M6 filter unit canister.

d. Effectiveness. The M10 gas filter will filter out all known toxic war gases.

e. Limitation. One limitation of the M10 filter is that it must be used with an M9 particulate-type filter.

f. Shipment. Five of these filters are shipped in a wooden box that weighs about 265 lb and occupies 17 cu ft.

g. Reference Publications.

Filter Unit, Gas-Particulate, GED and EMD, ABC-M6, TM 3-420, Department of the Army.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8, (Revised), Department of the Navy.

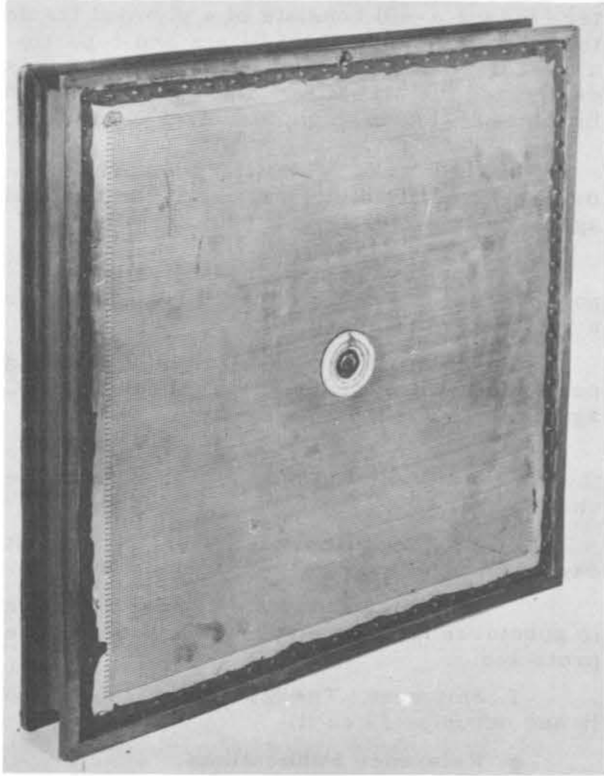


Figure A-39. Filter, Gas, 150-cfm, M10, for M6 Filter Unit

A43. FILTER, GAS-PARTICULATE, 600-CFM, M14, FOR M9 FILTER UNIT

a. Description. The gas-particulate filter (Figure A-40) consists of a plywood frame that contains 10 charcoal filters and 1 particulate filter. The complete replacement unit is designated the M14 filter. The filter is 34-3/8 in. long, 25-1/2 in. high, and 25-1/2 in. wide.

b. Use. The M14 filter is used to remove chemical, biological, and radiological agents from an air flow of 600 cfm.

c. Application. The M14 filter is a component of the M9 filter unit and is provided as a replacement.

d. Effectiveness. The combined gas and particulate filter will remove all known ABC agents.

e. Limitations. The M14 filters have the following limitations, which should be understood.

(1) The filter will not protect against carbon monoxide gas.

(2) The particulate filter is sensitive to punctures from blast pressure and must be protected.

f. Shipment. The M14 filter weighs 325 lb and occupies 12 cu ft.

g. Reference Publications.

Instruction Manual, EP-3, Protective Collector (Filter Unit), GED, 600-cfm, E-28, (M9), Department of the Army, 1957.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

Operation and Organizational Maintenance, Filter Unit, Gas-Particulate, EMD, 600-cfm, M9, TM 3-4240-208-12, Department of the Army, 1959.

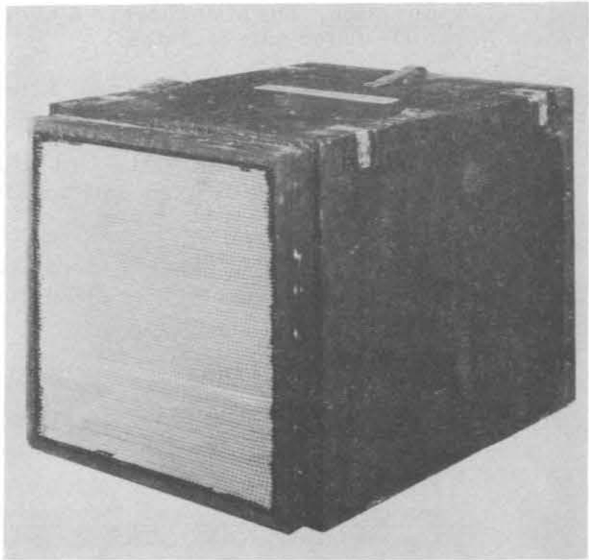


Figure A-40. Filter, Gas-Particulate, 600-cfm, M14, for M9 Filter Unit

A44. FILTER, PARTICULATE, 150-CFM, M9, FOR M6 FILTER UNIT

a. Description. The M9 filter panel (Figure A-41) consists of an aluminum frame that contains special material with interstices that are fine enough to stop the extremely small liquid and solid particles that are in the form of aerosols. Two M9 filters are required for each M6 unit. The size of the filter is 24 in. by 24 in. by 3-1/16 in.

b. Use. The M9 particulate filter is used to remove toxic liquid and solid particles from the air at the rate of 150 cfm. It is always used with a gas filter that filters gas from particle-free air.

c. Application. This filter is a component of the M6 filter unit canister, and it serves as a replacement when filters in the unit are expended.

d. Effectiveness. The M9 filter will stop liquid and solid particles and the gas filters are designed to stop gases by adsorption.

e. Limitation. The M9 particulate filter has the following limitations.

(1) It must be used with a gas-type M10 filter.

(2) It is subject to damage from nuclear blast pressures when the shelter is not protected with a blast closure device.

f. Shipment. Ten M9 particulate filters are shipped in a wooden box that weighs about 215 lb and occupies 17 cu ft.

g. Reference Publications.

Filter Unit, Gas-Particulate, GED and EMD, TM 3-420, Department of the Army.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8, (Revised), Department of the Navy.

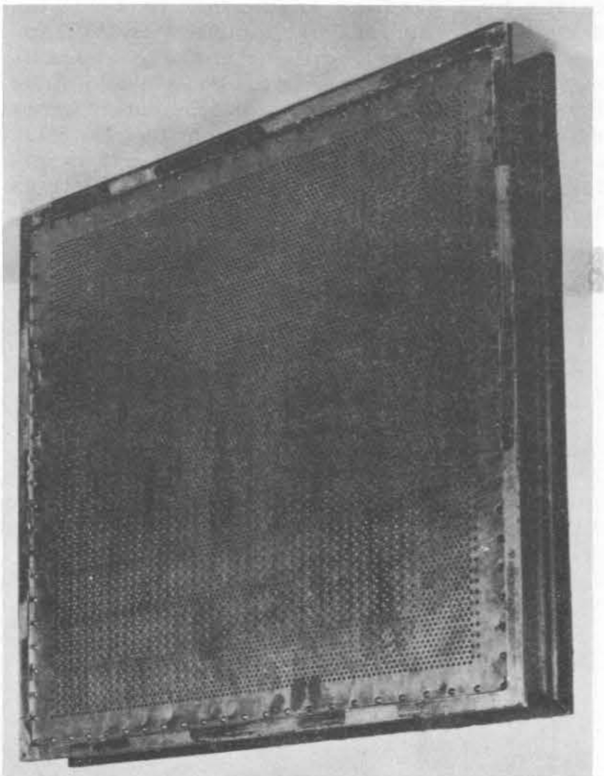


Figure A-41. Filter, Particulate, 150-cfm, M9, for M6 Filter Unit

A45. FILTER UNIT, GAS-PARTICULATE, GED, 300-CFM, ABC, M6

a. Description. The M6 filter unit (Figure A-42) is used to remove ABC contaminants from the air. The unit has a capacity of 300 cfm of filtered air against a minimum static head of 2 in. of water with a blower speed of 3,450 rpm. The filtering medium consists of charcoal and particulate paper that is contained in an aluminum canister. The unit is equipped with a centrifugal-type blower that is driven by a gasoline engine that is 1-1/2 hp, 4-cycle, air-cooled, and mounted on the canister. The overall dimensions are approximately 34 in. by 24 in. by 39 in. The unit is furnished with one inlet and one outlet wire-reinforced canvas hose, which has a 5-in. inside dimension and is 10 ft long with manifold. A muffler, exhaust tubing, and all fittings and J-bolts for installation are also provided. It is a light, compact, 400-lb unit that can be disassembled into 8 sections for one-man loads. It requires 5.8 sq ft of floor space.

b. Use. The M6 filter unit is used to remove ABC contaminants from air that is supplied to the pressurized areas so that personnel can work without donning gas masks.

c. Application. The M6 unit is designed for installation inside or outside a shelter or other building that requires protection. The choice of location depends on such factors as the noise of the motor, floor space, prevailing weather, and the convenience of personnel. When the unit is installed inside, contaminated air is drawn through the canister first and then pushed through the blower. When the unit is

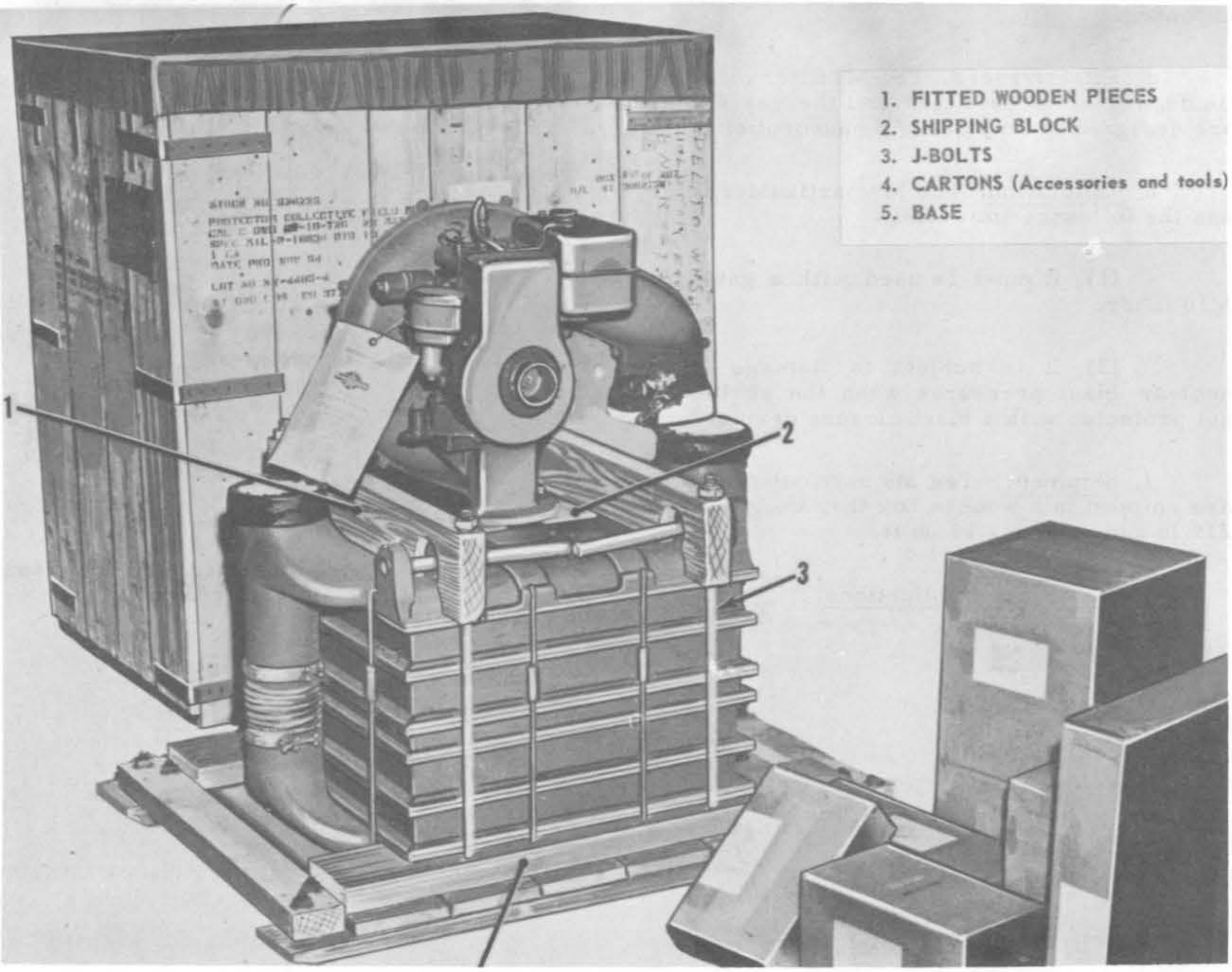


Figure A-42. Filter Unit, Gas-Particulate, GED, 300-cfm, ABC, M6

installed outside, the air is pushed through the canister by the blower.

d. Effectiveness. The M6 filter unit will filter out all known ABC contaminants.

c. Limitations. The M6 filter unit has the following limitations.

(1) This unit is portable and designed for only small shelters.

(2) It must be placed in separate and airtight rooms where the unit may be protected from blast pressures.

(3) The air inlet and exhaust must be protected by blast closure devices.

f. Shipment. The M6 filter unit is shipped in a wooden box that weighs 700 lb and occupies 37.1 cu ft.

g. Reference Publications.

Filter Unit, Gas-Particulate, GED and EMD, ABC-M6, TM 3-420, Department of the Army.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

Improvised CBR Protective Shelters, TM 3-350, Department of the Army.

A46. FILTER UNIT, GAS-PARTICULATE, GED, 600-CFM, M9

a. Description. The M9 gas-particulate filter unit (Figure A-43) is used to remove ABC contaminants from air that is supplied to buildings. It has a capacity of 600 cfm of filtered air against a static head of 2-1/2 in. of water with a fan speed of 3,450 rpm. The filtering media consist of charcoal filters and a particulate filter that is contained in a plywood housing. The two types together are known as M14 filter gas and particulate. The unit is equipped with a centrifugal-type blower that is driven by a 1-1/2 hp air-cooled gasoline engine. The unit is mounted on a wood skid. The approximate overall dimensions of the filter unit are: length, 81 in., width 30 in., and height, 40 in. It is furnished with one 10-ft section of flexible tubing that is 10 in. in diameter.

b. Use. This filter unit is used to remove ABC contaminants from air that is supplied to buildings, such as command centers, personnel shelters, and medical stations, so that personnel can work without donning gas masks.

c. Application. This unit is designed for installation either inside or outside a shelter or building that requires protection. Contaminated air is drawn in the screened blower inlet and forced through the particulate and gas filters.

d. Effectiveness. This gas-particulate unit will filter out all known ABC contaminants.

e. Limitations. This filter unit is designed for the protection of only 60 to 120 reasonably active persons in shelters, command centers, and similar areas.

f. Shipment. This filter unit is shipped in a wooden box that weighs 1,200 lb and occupies 60 cu ft.

g. Reference Publications.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

Instruction Manual EP-3, Protector Collective (Filter Unit) GED, 600-cfm, E-28 (M-9), Department of the Army, 1957.

Operation and Organizational Maintenance, Filter Unit, Gas-Particulate, EMD, 600-cfm, M9, TM 3-4240-208-12, Department of the Army, 1959.

NOTE: Other sizes with capacities of 1,200, 2,500, and 5,000 cfm are described in Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

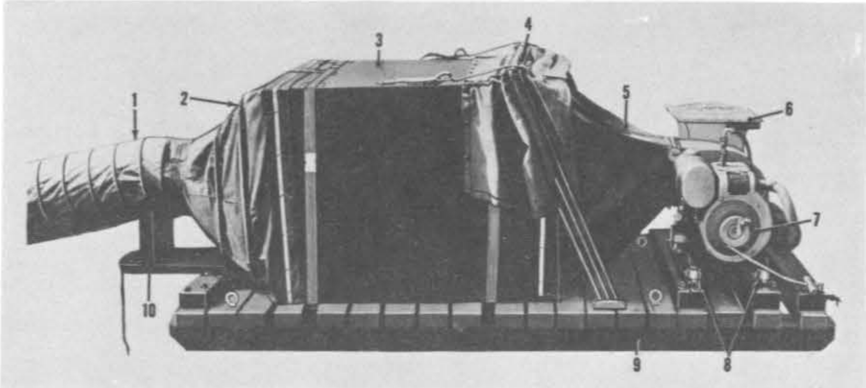


Figure A-43. Filter Unit, Gas-Particulate, GED, 600-cfm, M9

A47. MANOMETER

a. Description. The manometer (Figure A-44) consists of a glass U-tube about 12 in. high, half filled with a red oil indicating liquid, mounted on a metal backing, with a graduated scale to read air pressure in "inches of water."

b. Use. The manometer is used to indicate the air pressure inside a pressurized shelter.

c. Application. The manometer is installed on an inside wall with one end of the U-tube opened to the air inside the shelter and the other end connected to a rubber or copper tube that leads through the wall and opens to the outside air. The outside end of the tube should be so located and protected as to prevent erratic readings that might be caused by wind.

d. Effectiveness. The manometer records, in inches of water, the difference in air pressure between the inside and the outside of a shelter.

e. Limitations. The manometer has the following limitations.

(1) It must be accurately plumbed.

(2) At frequent intervals, zero adjustments are necessary either by moving the scale or by adding colored oil.

f. Shipment. One manometer is shipped in a fiberboard carton that weighs 2 lb and occupies about 0.20 cu ft.

g. Reference Publications.

Improvised CBR Protective Shelters, TM 3-350, Department of the Army.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

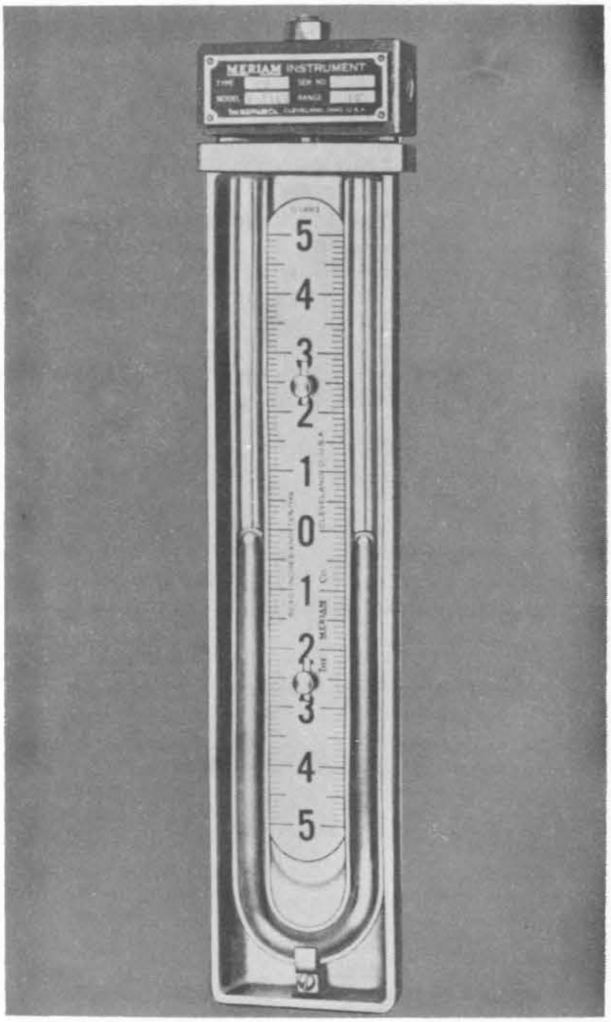


Figure A-44. Manometer

A48. REGULATOR, AIR PRESSURE, M1

a. Description. The M1 air pressure regulator (Figure A-45) consists of a 13- by 23-inch steel frame and a sliding panel that permits the changing of the size of the 9- by 9-inch opening. The regulator frame is bolted to an opening in the wall between the sections of the shelter and is cushioned with a pressed felt base to provide an airtight seal.

b. Use. The M1 regulator regulates the flow of air between the air locks of a protective shelter or between rooms inside a pressurized area where one of the rooms has an antiback-draft valve installed.

c. Application. The regulator is installed in partitions as necessary.

d. Effectiveness. The regulator is adjusted manually and is effective in regulating the air flow.

e. Limitation. One limitation of the M1 regulator is that it does not compensate for variations within pressurized shelters.

f. Shipment. Two regulators are shipped in a wooden box that weighs 50 lb and occupies 2 cu ft.

g. Reference Publications.

Accessory Equipment for Protective Shelters, TM 3-4240-203, Department of the Army.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

Improvised CBR Protective Shelters, TM 3-350, Department of the Army.

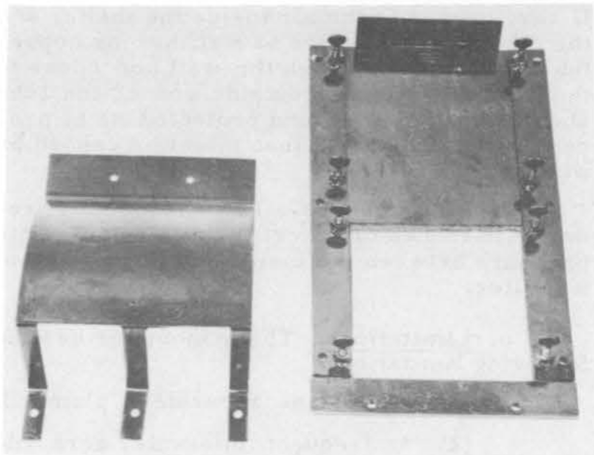


Figure A-45. Regulator, Air Pressure, M1

A49. VALVE, ANTIBACKDRAFT, M1

a. Description. The M1 antibackdraft valve (Figure A-46) consists of a duct that is 20° to the vertical. A stud that extends back into the opening is provided with a counterbalancing weight that may be manually adjusted to various positions, thereby varying the amount of force that is required to swing open the cover and relieve the pressure.

b. Use. This valve is installed in the walls of operation areas to regulate the pressure between the atmosphere and the operation area and to prevent the entrance of outside contaminated air when inside positive pressure drops to ambient pressure or when outside pressure suddenly increases because of winds.

c. Application. The antibackdraft valve is designed to perform three functions.

(1) It maintains a predetermined static pressure of nearly constant value within a pressurized shelter.

(2) It also prevents a reverse flow of air from the atmosphere into the shelter if an increase in outside pressure were to develop.

(3) The valve provides a means of determining the rate at which air is exhausted from the shelter to the atmosphere. During the pressurization of the shelter by the exhausting of air through the valve, the valve is adjusted to obtain the desired static pressure (pressure change across the valve). The valve cover closes automatically when the pressurizing system is turned off.

d. Effectiveness. The M1 valve operates effectively against normal winds.

e. Limitation. One limitation of the M1 valve is that it requires protection so that it will not be damaged or blown away by the blast of a bomb.

f. Shipment. The valve is shipped in a cardboard carton that weighs about 30 lb and occupies about 1.5 cu ft.

g. Reference Publications.

Accessory Equipment for Protective Shelters, TM 3-4240-203, Department of the Army.

Improvised CBR Protective Shelters, TM 3-350, Department of the Army.

Personnel Shelters and Protective Construction, NAVDOCKS TP-PL-8 (Revised), Department of the Navy.

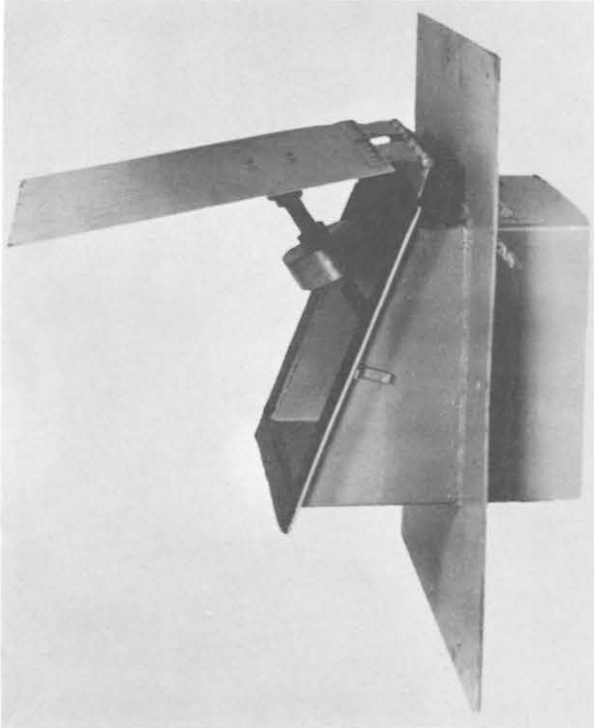


Figure A-46. Valve, Antibackdraft, M1

DECONTAMINATING MATERIAL

Items	79 - 91
Paragraphs	A50 - A60

A50. CITRIC ACID, COMMERCIAL GRADE, 50-LB CONTAINER

a. Description. The commercial grade citric acid is a triacid, $C_3H_4OH\ (CO_2H)_3$.

b. Use. Citric acid is used with water to increase the efficiency of radiological decontamination of selected portions of structures and equipment.

c. Application. A 2-percent solution (by weight) of citric acid with water is used to scrub the selected portions of structures and equipment to reduce radiological contamination.

d. Effectiveness. Citric acid increases the efficiency of decontamination of the surfaces that have a light film of oil or grease.

e. Limitation. One limitation of the use of citric acid is that it is not logistically feasible to use the acid in solution for large-scale decontamination procedures because of the large quantities that are required.

f. Shipment. The acid is shipped in a fiberboard container that weighs 65 lb (net weight 50 lb) and occupies 1.4 cu ft.

g. Reference Publications.

Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13, Department of the Navy.

Decontamination, TM 3-220, Department of the Army, 1953.

A51. CITRIC ACID, MONOHYDRATE, TECHNICAL (ANTISET M1) 6-1/2-LB CONTAINER

a. Description. The M1 antiset contains not less than 99 percent, by weight, of monohydrate citric acid ($C_6H_8O_7H_2O$).

b. Use. Citric acid is used to facilitate the flow and to prevent the drying or "setting" of the slurry when it is used as a decontaminant for CW agents.

c. Application. The citric acid and water are mixed together before the bleach is added to the solution. The proportions are 1/2 lb of citric acid to 100 lb of bleach to approximately 17 gal of water. When the solution is mixed in the 400-gal decontaminating apparatus, 6-1/2 lb of citric acid and 225 gal of water are mixed and then 1,300 lb of bleach are added and mixed.

d. Limitation. One limitation is that the water that contains citric acid must be agitated for about two minutes to dissolve the solid.

e. Shipping. Citric acid is shipped in a fiberboard container that weighs 7.2 lb and occupies 0.2 cu ft.

f. Reference Publications.

Decontamination, TM 3-220, Department of the Army.

Decontaminating Apparatus, Power-Driven, Truck-Mounted, M3A2, TM 3-223, Department of the Army.

Decontaminating Apparatus, Power-Driven, Skid-Mounted, M6, TM 3-406, Department of the Army.

g. Antiset, Decontaminating Slurry, M2. A new antiset, M2, is intended for use in place of the M1 antiset. The M2 material is compounded from equal weights of citric acid and sodium tripolyphosphate. This antiset is packaged in a fiberboard drum that contains 13 lb of material. The contents of one drum are approximately enough to provide the required 1 percent additive for one batch of bleach slurry (400-gal tank). Both the old and the new antiset appear to provide equal antiset capability, but the M2 appears to improve the dispersion properties of the bleach in water and also to provide a more uniform suspension. Both antisets cost about the same, but because of the advantages of the M2 antiset, it will be procured in the future.

A52. DANC SOLUTION UNIT, 3-GAL, M4

a. Description. The M4 DANC solution unit is a mixture of a powder (RH-195) and a solvent (acetylene tetrachloride).

b. Use. DANC solution is used to decontaminate weapons, instruments, vehicles, equipment, and metal surfaces that have been contaminated by vesicant CW agents.

c. Application. The dual container holds the correct proportions of the RH-195 and the acetylene tetrachloride. The solution is made by pouring the contents of the upper compartment into the contents of the lower compartment, stirring the mixture thoroughly, and straining the solution into a 3-gal portable decontaminating apparatus. The DANC solution can be applied with a broom or with swabs. When smaller quantities are desired, the proportions by volume are 1 part of RH-195 to 6 parts of the solvent, and the proportions by weight are 1 part of RH-195 to 15 parts of the solvent.

d. Effectiveness. DANC destroys most blister gases within one-half an hour.

e. Limitations. The DANC solution unit has the following limitations.

(1) DANC solution is unstable after it is mixed; therefore the solution should not be made until it is actually needed.

(2) It is not effective against G-agents.

(3) The residue is corrosive if it is left in prolonged contact with metal surfaces.

(4) DANC tends to soften rubber and plastic.

(5) DANC is very toxic.

(6) Personnel must wear protective clothing and masks when they are using DANC.

f. Shipment. The DANC solution unit is shipped in a 3-gal dual-compartment container that weighs about 59 lb and occupies 1.2 cu ft.

g. Reference Publications.

Decontamination, TM 3-220, Department of the Army.

Military Chemistry and Chemical Agents, TM 3-215, Department of the Army.

NOTE: There is presently in the supply system some bulk RH-195 and tetrachloroethene that may be used to prepare DANC solution. The bulk material is to be mixed in the proportions by volume of 1 part of RH-195 to 6 parts of tetrachloroethene, and by weight of 1 part of RH-195 to 15 parts of tetrachloroethene. When 37 lb 6 oz of tetrachloroethane are mixed with 2 lb and 8 oz of RH-195, the volume is equivalent to a 3-gal DANC solution unit.

A52.1 DEVELOPMENT OF UNIVERSAL CW DECONTAMINANT

a. Description. DS2 is a new CW decontaminant that is currently undergoing field tests. If the results are successful, and preliminary reports are quite promising that they will be, the new decontaminant should be standardized in about a year. DS2 has the following composition by weight:

Diethylenetriamine	70%
Methyl Cellosolve	28%
Sodium Hydrozide	2%

b. Use. The DS2 solution will decontaminate mustards, G-agents, and V-agents to -25° C in concentrations to meet military requirements. It is expected to replace DANC.

c. Application. DS2 will be used in limited amounts in the same manner as DANC is currently being used.

d. Characteristics. DS2 has the following characteristics.

(1) Test data indicate that, for all practical purposes, DS2 is noncorrosive to the common metals, such as steel, brass, and magnesium.

(2) The data relative to the corrosive effects on aluminum and its alloys are questionable, and this problem is currently being investigated.

(3) DS2 seems to have very little effect on the following materials: sateen, natural rubber, GRS rubber, neoprene rubber, butyl rubber, plexiglas, and bakelite.

(4) Wool is affected quite readily.

(5) The flash point of DS2 is such that it should not present any fire or explosion hazard under field conditions.

(6) DS2 will effectively decontaminate painted surfaces, but it will probably affect the paint.

(7) It is stable under all climatic conditions when it is stored in cheap steel containers.

A53. DECONTAMINATING AGENT, STB

a. Description. The STB (supertropical) decontaminating agent, bleach, is referred to as bleaching powder, bleaching material, chlorinated lime, or chloride of lime. It is a white powder that contains about 30 percent available chlorine.

b. Use. Bleach is used either as a dry mix or as a wet mix to decontaminate exterior surfaces and ground that is contaminated by CW or BW agents.

c. Application.

1. Dry Mix. The dry mix is prepared with 2 parts of bleach to 3 parts of earth, by volume. As a dry mix, it may be used in a shuffle box to decontaminate the shoes of personnel before they enter clean areas and shelters.

2. Wet Mix.

(a) Slurry. As a slurry, the wet mix is used on vertical surfaces for both BW and CW decontamination. The slurry consists of 225 gal of water, 6-1/2 lb of citric acid (antiset M1), and 1,300 lb of bleach, which makes one 400-gal batch of slurry to cover 1,300 sq yd with the average coverage for smooth surfaces. The antiset must be mixed with the water before the bleach is added.

(b) Clear Solution. As a clear solution, the wet mix is used on horizontal surfaces for BW decontamination only. For CW decontamination on horizontal surfaces, the slurry mix should be used. The solution consists of 7 parts of bleach to 93 parts of water by weight. It is applied with either the M1 3-gal or the 400-gal decontaminating apparatus. The average coverage is 1/8 gal per sq yd for concrete surfaces and 1/2 gal per sq yd for compacted earth. Other surfaces, such as grass, require proportionally more, up to 1 gal per sq yd.

d. Effectiveness. Bleach destroys mustard gases, lewisite, and, to a limited extent, nerve gas by converting them into harmless or less toxic compounds. It also destroys BW agents. As long as bleach retains its chlorine content, it serves to seal in the vapors or neutralize them as they rise to the surface of the ground.

e. Limitations. The STB bleach has the following limitations.

(1) Bleach is corrosive to metal and fabrics.

(2) Breathing and continued absorption through the skin is harmful.

(3) Personnel must wear masks.

(4) Vapors from the reaction of bleach with G-agents are toxic.

(5) Dry bleach reacts violently with liquid mustard gases.

(6) Bleach loses its chlorine content when it is in storage over a period of time.

(7) Bleach requires continuous surveillance. Ten percent available chlorine is considered the lower usable limit. For test procedures, see ABC Warfare Defense Materiel Inspection and Storage, NAVDOCKS TP-PL-19, Department of the Navy.

f. Shipment. Bleach is packaged in 8-gal metal drums that weight 61 lb.

g. Reference Publications.

Decontamination, TM 3-220, Department of the Army.

Decontaminating Apparatus, Power-Driven, Skid-Mounted, M6, 400-Gallon, TM 3-406, Department of the Army.

Decontaminating Apparatus, Power-Driven, Truck-Mounted, M3A2, 400-Gallon, TM 3-223, Department of the Army.

Military Chemistry and Chemical Agents, TM 3-215, Department of the Army.

A54. DETERGENT, WETTING AGENT (POWDER AND LIQUID)

a. Description. The powder-type wetting agent is a synthetic organic detergent that consists of alkylaryl sodium sulfonate. It is a white, flaky solid that is soluble in soft, hard, and sea water. The liquid-type wetting agent is a general purpose nonionic water soluble, Type 1.

b. Use. Either the powder or liquid detergent may be added to chlorine solutions to act as a wetting agent.

c. Application. To make a solution for the decontamination of BW agents on exterior surfaces, 7 parts of STB bleach and 93 parts of water are mixed and to the mixture is added 1/2 of 1 percent by weight, or 0.04 lb, of either the powder or the liquid for each gallon of the mix. To make a solution for use as laundry water for the decontamination of BW agents on clothing, 1 part of STB bleach and 99 parts of water are mixed and to this mixture is added 1/2 of 1 percent by weight, or 0.04 lb, of either the powder or the liquid for each gallon of the mix.

d. Effectiveness. Either the powder or the liquid detergent assures complete wetting of the surface and the material.

e. Shipment. The detergent powder is shipped in a fiberboard drum that weighs 225 lb and occupies 7.0 cu ft. The liquid detergent is shipped in 1-gal cans, with 6 cans to a shipping case.

A55. ETO-FREON DISPENSER, 50-ML, 12-OZ, M1

a. Description. The nonflammable gas that is contained in this dispenser is a mixture of 11-percent ethylene oxide, 44-1/2-percent Freon 11, and 44-1/2-percent Freon 12 propellants. This gas is contained in a 50-ml metal dispenser with a breakoff valve stem.

b. Use. The ETO dispenser (Figure A-47) is used to decontaminate clothing and other personnel equipment after a BW attack.

c. Application. The clothing that is to be decontaminated is placed loosely in a gas-proof bag, or an individual protective cover may be substituted. One ethylene oxide dispenser is placed in the bag; and after the bag is tied securely, the dispenser is discharged in the bag by breaking off the valve stem. The sealed bag is rolled carefully on the ground for 5 minutes to disperse the gas throughout the clothing, then the bag is stored at a minimum temperature of 72° F for 12 hours.

d. Effectiveness. The ETO-Freon gas will effectively decontaminate all BW contaminated clothing and other personnel items.

e. Limitations. The ETO dispenser has the following limitations.

(1) The gas is toxic and can be used only in a well-ventilated building or in the open.

(2) Personnel who are doing the work must wear protective clothing and equipment.

(3) Clothing and other personnel equipment must be aerated until the odor can not be detected, that is, 15 minutes for clothing and several hours for rubber and leather items.

f. Shipment. Shipping data are being developed for this item.

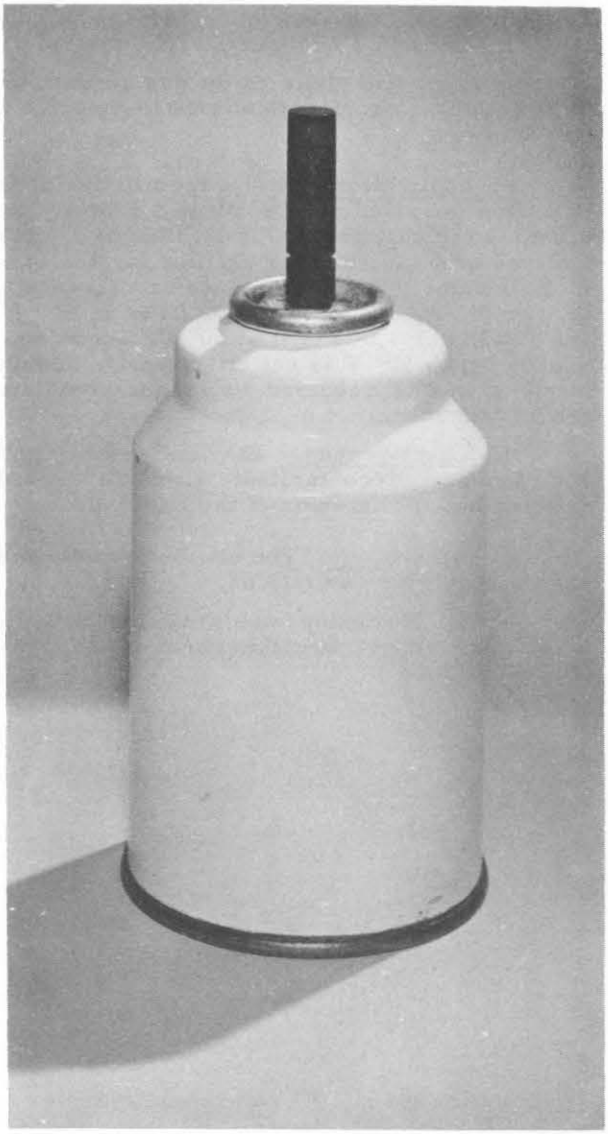


Figure A-47. ETO-Freon Dispenser, 50-ml, 12-Oz, M1

A56. ETHYLENE OXIDE GAS IN 15-LB CYLINDER

a. Description. The decontaminating gas is a mixture of ethylene oxide and Freon, and it is contained in a 15-lb steel cylinder.

b. Use. Ethylene oxide gas is used to decontaminate equipment and clothing after a BW attack.

c. Application. After a room or chamber has been gasproofed with plastic coating, as discussed in paragraph 4E7.02, the gas is discharged into the room or chamber at the rate of 30 lb per 1,000 cu ft of space at a temperature of 70° F, 120 lb per 1,000 cu ft at 60° F, and 180 lb per 1,000 cu ft at 50° F. Decontamination below 50° F is not effective. A contact of 60 hours is required to assure complete decontamination.

d. Effectiveness. Ethylene oxide gas will effectively decontaminate all contaminated articles and the interior of the building.

e. Limitations. The ethylene oxide gas has the following limitations.

(1) Personnel who are doing the work must wear oxygen breathing masks and protective clothing.

(2) The interior of the building must be aerated until the odor can not be detected.

(3) Clothing and other personnel equipment must be aerated until the odor can not be detected, that is, 15 minutes for clothing and several hours for rubber and leather items.

(4) Decontamination is retarded in the presence of excess moisture.

(5) It is extremely flammable and must be kept away from heat and sparks.

f. Shipment. This gas is shipped in 15-lb high-pressure gas cylinders.

NOTE: In the event that personnel come in contact with the gas, they should immediately remove all clothing and flush the skin and eyes with large quantities of water for at least 15 minutes. The eyes should then be checked by a medical officer.

A57. FORMALIN

a. Description. Formalin is a mixture of methanol and 37-percent formaldehyde (HCHO). Formalin is also known as formaldehyde solution.

b. Use. When formalin is mixed with additional methanol, the vapor is used to decontaminate and sterilize the interior of a building and also the equipment that is contained in the building.

c. Application. To make a formalin mix for decontamination purposes, 5 parts of stock formalin are mixed with 3 parts of methanol. Doors, windows, and other openings of buildings must be closed. Normal openings around windows and doors need not be sealed. The formalin mix is vaporized by a fog applicator, steam, or a high-pressure sprayer. The bactericidal action of formalin improves with increased relative humidity. One quart of diluted formalin is required to decontaminate and sterilize 1,000 cu ft of space above a temperature of 70° F with a relative humidity of 70%. The following amounts of mixed solution are required to decontaminate 1,000 cu ft of space at various temperatures.

Temperature (° F)	Quantity
Above 70	1 qt
60 - 70	1/2 gal
40 - 60	1 gal
Below 40	Not effective

Regardless of the temperature, the humidity should be maintained at 70% or above. At 70° F the minimum contact time is between 4 and 8 hours.

d. Effectiveness. Formalin is one of the best decontaminants for interiors. It will effectively decontaminate and sterilize all infected equipment except that which is contaminated by dried botulinus toxin.

e. Limitations. Formalin has the following limitations.

(1) The vapor is highly toxic.

(2) The source of the steam that is used to vaporize formalin is outside the area that is being decontaminated.

(3) The end product of formalin is toxic and the surfaces must be washed with hot water.

(4) Formalin will not penetrate cloth and similar material as effectively as some sterilizing gas.

(5) An open flame is not suitable for vaporizing.

(6) Decontamination below 50° F is not recommended.

(7) Formalin may cause damage to delicate instruments, and dampness may curl and ripple paper.

(8) At least a 24-hr aeration period is required before a building is usable after decontamination.

(9) Personnel must wear masks when they are handling the solution. For extended exposures, oxygen breathing masks should be used.

f. Shipment. Stock formalin is shipped in 55-gal metal drums that weigh 500 lb and occupy 9.3 cu ft.

A58. METHANOL (METHYL ALCOHOL)

a. Description. Methanol (CH_3OH) is a toxic, flammable liquid.

b. Use. Methanol is used as an admixture with formalin when water is not available. The recommended mixture is 3 parts of methanol to 5 parts of formalin.

c. Effectiveness. Because methanol is used as an admixture, its effectiveness is governed by the primary constituent of the mixture.

d. Shipment. Methanol is shipped in 5-gal containers.

A59. PLASTIC COATING, STRIPPABLE

a. Description. Strippable plastic coating is a solution that forms a tough, elastic, waterproof skin. When it dries, it can be stripped from the surface to which it was applied. It is a vinyl plastic that is dissolved in acetone or methyl ketone. It is resistant to most acids, alkaline solutions, oils, grease, alcohol, water, weather, and sunlight.

b. Purpose. The coating is used to gasproof a room for the decontamination of BW agents with ETO-Freon gas.

c. Application. The coating is applied by spraying over cracks, around windows, and doors with an ordinary paint spray gun. A nozzle that sprays a band 6 in. to 8 in. wide at a 12-in. distance is recommended. A single pass sprays on an average thickness of about 0.04 in. About 16 gal per 100 sq ft are required to obtain this thickness of coating, which dries completely in 16 hours at 70° F.

d. Effectiveness. Strippable plastic coating can make a room absolutely gasproof.

e. Limitations. Strippable plastic coating has the following limitations.

(1) Cracks over 1/8-in. wide must be sealed with adhesive tape, caulking compound, or plaster prior to the spraying.

(2) The thickness of the coating necessitates a long drying period.

(3) Solids tend to separate from the vehicles during storage.

f. Shipment. The strippable plastic coating is shipped in 55-gal metal drums that weigh 440 lb and occupy 9.3 cu ft.

g. Reference Publication.

Strippable Coating; Application and Maintenance, OP 1483, Bureau of Ordnance, 1954.

A60. TAPE, ADHESIVE, PRESSURE-SENSITIVE

a. Description. Pressure-sensitive adhesive tape is light gray treated cloth that is provided in rolls that are 60 yd long and 2-1/2 in. wide.

b. Application. The tape is used to seal cracks 1/8 of an inch and larger inside a building or room that is to be used as a decontamination chamber. Plastic coating is applied over the tape to complete the seal.

c. Limitation. One limitation in the use of the tape is that the surfaces on which the tape is used must be cleaned.

d. Shipment. One roll of tape is packed and shipped in a paper carton that weighs 2.6 lb and occupies .066 cu ft.

DECONTAMINATING EQUIPMENT

Items	92 - 101
Paragraphs	A61 - A65

A61. DECONTAMINATING APPARATUS, PORTABLE, 3-GAL, M1

a. Description. The M1 portable apparatus (Figure A-48) is an item of standard decontaminating equipment that is intended primarily for use with DANC solution. It is a pressure-type spray apparatus that consists of a 3-gal tank with a shoulder strap, an air pump, a hose, a shut-off valve, and a nozzle. A funnel and a mixing paddle are provided as auxiliary equipment.

b. Use. The M1 portable apparatus is used to spray DANC solution on equipment that has been contaminated by CW agents.

c. Application. The decontaminating apparatus is carried empty and is filled with the DANC solution immediately before it is used. On the average the 3-gal tank of DANC will cover 50 sq yd of surface.

d. Effectiveness. The portable apparatus is effective for relatively small decontamination jobs, such as for decontaminating trucks and other similar types of equipment.

e. Limitations. The M1 portable decontaminating apparatus has the following limitations.

(1) It can not be filled with more than 3 gal of liquid.

(2) The solution must be filtered.

f. Shipment. Two of the M1 units are packed in a wooden box that weighs 75 lb and occupies 8.7 cu ft.

g. Reference Publications.

Decontamination, TM 3-220, Department of the Army.

Chemical Decontamination Company, FM 3-70, Department of the Army.

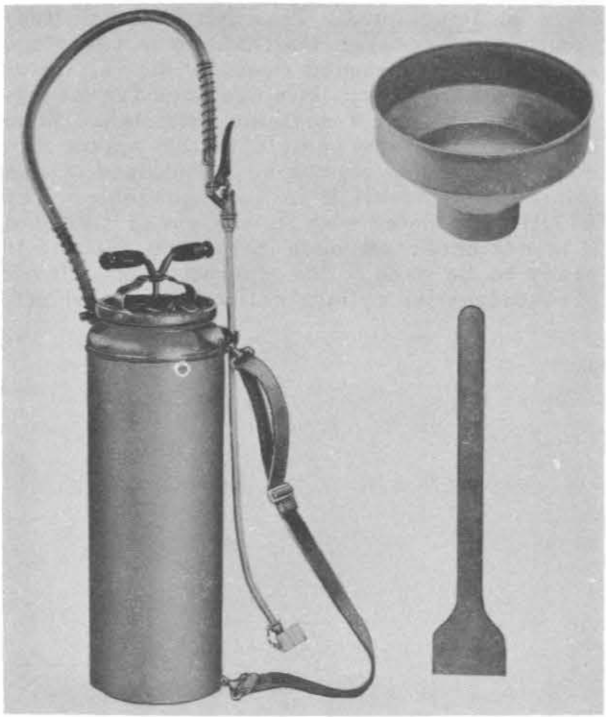


Figure A-48. Decontaminating Apparatus, Portable, 3-Gal, M1

A61.1 E17R1 DECONTAMINATING APPARATUS, PORTABLE, 1-1/2-QT

a. Purpose. The E17R1 decontaminating apparatus was developed for the purpose of applying DS2 and to replace the M2, 1-1/2 qt, apparatus that is now considered a limited standard. Therefore, the E17R1 will be standardized at about the same time as the DS2 is standardized. (See paragraph A52.)

b. Description. This unit utilizes nitrogen gas to discharge the DS2 and is therefore more simply designed than the M2 is, which utilizes a hand pump. It is designed for mounting on a vehicle. It contains sufficient DS2 to decontaminate the vehicle to the extent that continued operation can be maintained with a minimum of risk. It is nonexpendable. The E17R1 is mounted with its content of DS2, but it is not under nitrogen pressure until it is ready to be used. The operation of a lever pressurizes the cylindrical body of the E17R1. Nitrogen is packaged in a pressurized cylinder that is similar to the CO_2 cylinders that are used to inflate life jackets. Nitrogen was selected as the propellant for this unit because of its inertness to DS2 and because it does not present a fire hazard.

c. Effectiveness. Test data indicate that the E17R1 will satisfactorily spray the entire charge of DS2 in temperatures as low as +12° F with one N2 cartridge. Between +12° F and -25° F part of the DS2 is adequately sprayed with the first N2 cartridge, but a point is reached where the spray is not broken up adequately and it comes out as a solid stream. At this point, a second cartridge is inserted, and the remainder of the DS2 is sprayed. The initial pressure in the E17R1 cylinder, at the time the N2 is released, is 240 psig. The final pressure is 25 psig when 1 cartridge is used.

A62. DECONTAMINATING APPARATUS, POWER-DRIVEN, SKID-MOUNTED, M4 DECONTAMINATING APPARATUS, POWER-DRIVEN, SKID-MOUNTED, M6 DECONTAMINATING APPARATUS, POWER-DRIVEN, TRAILER-MOUNTED, M8 DECONTAMINATING APPARATUS, POWER-DRIVEN, TRUCK-MOUNTED, M3A2 and M3A3

a. Description.

(1) The M4, M6, and M3A2 types of power-driven decontaminating apparatus (Figures A-49, A-50, and A-51) are modified commercial-types of orchard sprayers that are adapted to spray bleach slurry. Each apparatus consists essentially of a 400-gal tank that is equipped with a rotary agitator, a 3-cylinder piston-type pump, and a relief valve. The discharge rate is 20 gpm (nozzle capacity), but the pump's capacity is 35 gpm at a working pressure of 400 psi. The 15 gpm difference is for the recirculation of the mix.

(2) The M4 and the M6 models are skid-mounted, have auxiliary engines rated at 22 hp that are mounted as part of the apparatus and that supply the power for the operation of the pump and the agitators. The M4 and the M6 models require a 2-1/2-ton, 6 x 6 truck for transporting. The M3A2 apparatus is permanently mounted on a standard 2-1/2-ton, 6 x 6 truck, which provides the power for transporting and operating the pump. The apparatus may be used also as a field shower unit. The M3A3 apparatus is the same as the M3A2 type except that the M3A3 has a steel tank whereas the M3A2 has a wooden tank.

(3) The M8 (Figure A-52) is also a commercial-type sprayer with a 200-gal steel tank that is mounted on a two-wheel trailer. The M8 is powered by a 15-hp, 4-cylinder, air-cooled gasoline engine, and has a reciprocating pump with a capacity of 20 gpm at 600 psi. It has a rear-mounted spray platform with 100 ft of 3/4-in. i. d. hose. The trailer has a retractable landing leg and lunette for towing by military vehicles of the 3/4-ton class.

b. Use. These various types of apparatus are used to spread decontaminating materials, such as slurry and other solutions, over large areas and surfaces after a BW or a CW attack. Spraying by means of a decontaminating apparatus is the only convenient method of treating the exterior of contaminated buildings.

c. Application and Time Cycle. The procedure and time schedule to be observed in operating the different types of decontaminating equipment are shown in the following tabulation.

Procedure	Time cycle (min)	
	M4, M6, M3A2	M8
Filling water from stream or other source	10	5
Mixing antiset	2	2
Filling tank with bleach	20	10
Mixing bleach with water	15	15
Spraying	20	10

The average coverage with slurry on smooth surfaces for each filling is 1,300 sq yd for the M4, M6, and M3A2 and 600 sq yd for the M8 apparatus. The slurry mixture for each filling for the M4, M6, M3A2, and M8 decontaminating apparatus is prepared in the proportions shown in the following tabulation.

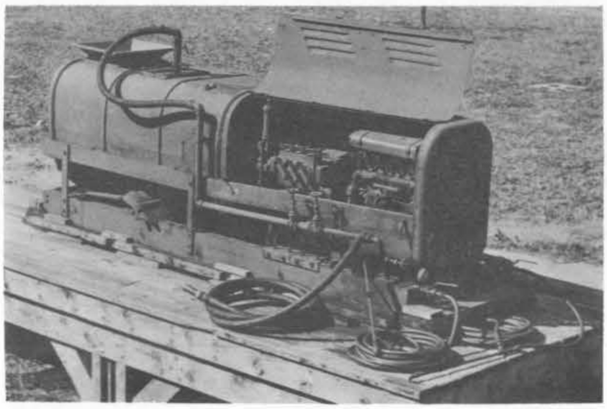


Figure A-49. Decontaminating Apparatus, Power-Driven, Skid-Mounted, M4, 400-Gal

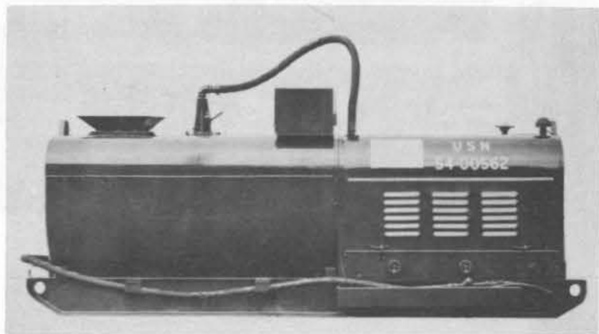


Figure A-50. Decontaminating Apparatus, Power-Driven, Skid-Mounted, M6, 400-Gal

Ingredients	Quantities	
	M4, M6, M3A2	M8
Water	225 gal	113 gal
Bleach	1,300 lb	650 lb
Antiset	6.5 lb	3.0 lb

An operating crew of four men, in addition to the mixing crew, is required for the most efficient operation.

d. Limitations. The decontaminating apparatus has the following limitations.

(1) It can not be used in temperatures below 20° F because the slurry thickens.

(2) The equipment must be thoroughly cleaned after each use.

e. Shipment. The different types of decontaminating apparatus are shipped as follows.

(1) The M4 decontaminating apparatus, prepared for shipment, weighs 4,600 lb and occupies 270.0 cu ft.

(2) The M6 decontaminating apparatus, prepared for shipment, weighs 4,925 lb and occupies 270.0 cu ft.

(3) The M3A2 decontaminating apparatus, prepared for shipment, is 98 in. high, 252-1/2 in. long, and 87 in. wide. It weighs 11,090 lb and occupies 1,103 cu ft.

(4) The M8 decontaminating apparatus, prepared for shipment, weighs 2,080 lb and occupies 240.0 cu ft.

f. Reference Publications.

Decontaminating Apparatus, Power-Driven, Skid-Mounted, M4, 400-Gal, TM 3-222, Department of the Army.

Decontaminating Apparatus, Power-Driven, Skid-Mounted, M6, 400-Gal, TM 3-406, Department of the Army.

Decontaminating Apparatus, Power-Driven, Truck-Mounted, M3A2, 400-Gal, TM 3-223, Department of the Army.

An instruction manual that is prepared by the manufacturer is furnished with the M8 equipment.

Chemical Decontamination Company, FM 3-70, Department of the Army.

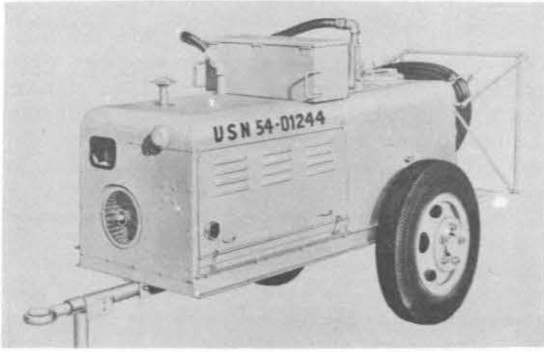


Figure A-52. Decontaminating Apparatus, Power-Driven, Trailer-Mounted, M8, 200-Gal

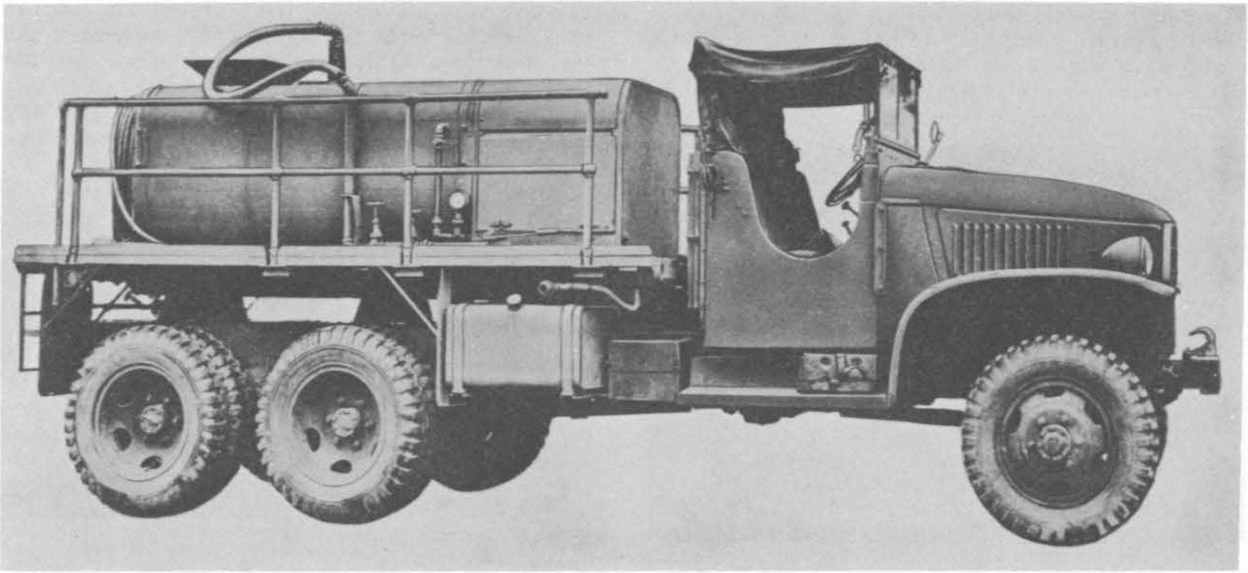


Figure A-51. Decontaminating Apparatus, Power-Driven, Truck-Mounted, M3A2, 400-Gal

A63. DISPENSER, SIMULANT AGENT, BGI, 12-OZ, M1

a. Description. The BGI dispenser (Figure A-53) is a commercial pressurized container that is filled with 2 grams of bacillus globigii and 300 grams of Freon 12 gas. The container is 2-7/8 in. by 4-11/16 in.

b. Use. The dispenser is primarily intended for special training of ABC personnel in the collection of biological samples with the M17 biological agent sampling kit. (See Figure A-19.)

c. Application. The simulant agent is used by instructors for training exercises. It may be sprayed in the air, on the walls, floor, equipment, clothing, food, and water. It is then collected with the BW sampling kit and forwarded to a medical laboratory for identification under a microscope.

d. Limitation. One limitation of the dispenser is that it has a shelf life of about one year.

e. Shipment. Twenty-four dispensers are packed in a fiberboard box that weighs about 24 lb and occupies about 1 cu ft.

f. Reference Publication.

CBR Training Exercises, FM 21-48, Department of the Army.

Figure A-53. Dispenser, Simulant Agent, BGI, 12-Oz, M1

A64. GENERATOR, FOG, INSECTICIDAL, 40-GPH

a. Description. The 40-gph insecticidal fog generator (Figure A-54) is a self-contained portable unit that is furnished with all necessary fittings and accessories.

b. Use. The generator is used primarily to dispense formalin as a vapor for the biological warfare decontamination of the interior of large buildings. It can also be used for dispensing insecticidal solutions in the interior of buildings and on open terrain.

c. Effectiveness. The formalin vapor that is produced is effective for more than 200 ft in an open room or building. Because of the many variations in building layout, the number of generators that may be required for effective decontamination may not be established. It will be necessary to observe the operation of the unit and to generate the vapor from as many places as necessary to secure complete coverage of the building. Paragraph A57 in this Appendix contains a discussion on formalin.

d. Limitation. The insecticidal generator has the following limitations.

(1) It must be carried by a small truck, jeep, or flat-bed hand truck and operated from the exterior of the building.

(2) Because the formalin is vaporized at a temperature of about 1,000° F, care must be exercised to prevent fires in the building.

e. Reference Publication.

See the instruction manual that is furnished with the equipment.

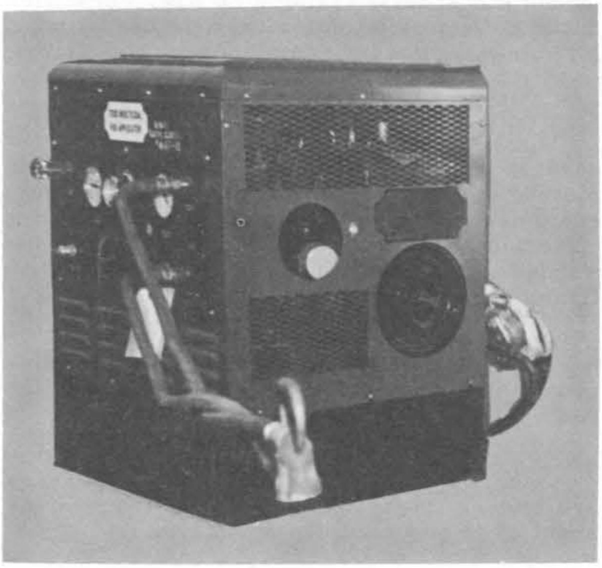


Figure A-54. Generator, Fog, Insecticidal, 40-gph

A65. HYPOCHLORINATION UNIT, WATER-PURIFICATION

a. Description. The water-purification hypochlorination unit (Figure A-55) is designed for water flows between 2 gph and 100 gph. Its performance is as follows.

Maximum water flow treated	100 gpm
Minimum water flow treated	2 gpm
Automatic proportioning range	10 to 1
Maximum hypochlorinator pumping rate	60 gal/24 hr at 12 strokes/min
Minimum allowable water pressure	10 psi
Maximum allowable water pressure	125 psi

b. Use. This hypochlorination unit is used for the chlor-dechlor process to dechlorinate water that has been superchlorinated for BW decontamination.

c. Application.

(1) The hypochlorinator is connected to the water line. Dechlorinating solutions are injected into the water line. Water is treated to 10 ppm available chlorine and held for one hour, then it is dechlorinated. Dechlorinating agents and the theoretical amounts that are required to dechlorinate 1 ppm of chlorine are given in the following tabulation.

Agent	Amount
Sulfur dioxide, SO_2	1 ppm
Sodium bisulfite, $NaHSO_3$	2 ppm
Sodium metabisulfite, $Na_2S_2O_5$	1.3 ppm
Sodium thiosulfate, $Na_2S_2O_3.5H_2O$	7 ppm

(2) The hypochlorination unit can be inserted in series with the water main or connected with a bypass around a restriction in the water main by using the bypass assembly.

(3) In addition, there is provided a comparator, with a bottle of orthotoluidine reagent, dropper, and test tubes, which is used to determine the amount of excess or "residual chlorine" in the treated water. It may also be used to determine the acidity or alkalinity of the water.

d. Effectiveness. The chlor-dechlor process is highly efficacious in destroying all pathogens, toxins, and protozoa. It might be operationally difficult to hold all water with 10 ppm residual for an hour and then introduce the dechlorinating agent unless there is a sufficient amount of clear-well storage in the plant.

e. Limitations. The hypochlorination unit has the following limitations.

(1) The use of a hypochlorinator is dependent on existing facilities and conditions.

(2) It is used for BW agents only.

f. Shipment. The hypochlorinator is shipped in a box that weighs 175 lb and occupies 8.7 cu ft.

g. Reference Publication.

Hypochlorination Unit, Automatic, Portable, 2- to 100-gpm Flow, TM 5-2032, Department of the Army.

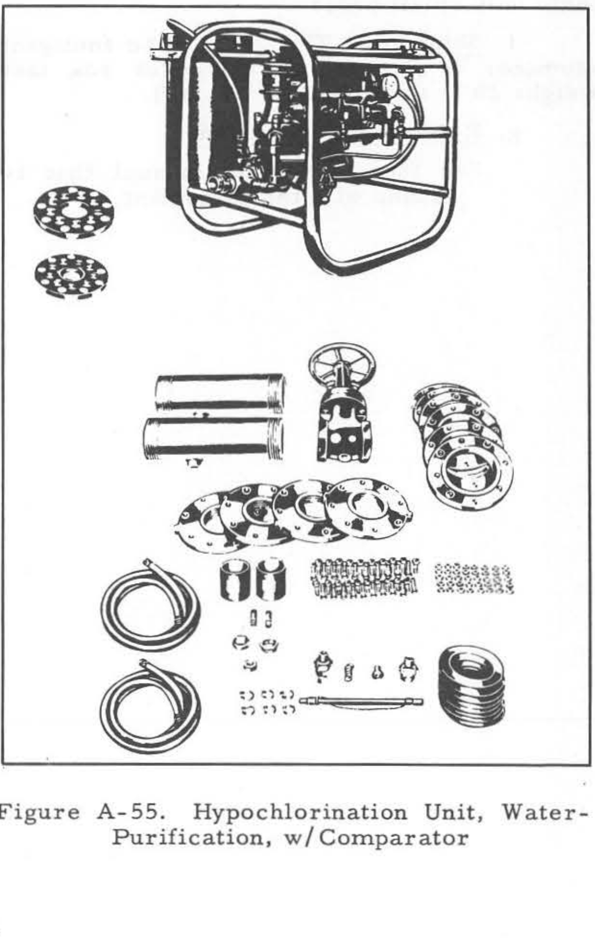


Figure A-55. Hypochlorination Unit, Water-Purification, w/Comparator

A66. PORTABLE FUMIGANT ATOMIZER, 3-GPH

a. Description. The portable fumigant atomizer (Figure A-56) is a commercial item for vaporizing formalin or insecticides. The atomizer utilizes a vacuum that is created in a hollow, spinning head to draw fluid from a 3-gal reservoir through a hollow motor shaft. The motor is rated at 1/2 hp at 10,500 rpm. The dimensions are about 14-1/2 in. by 12-1/4 in.

b. Use. The atomizer is used to dispense the formalin as a vapor for BW decontamination of the interior of small structures.

c. Application. The 3-gal reservoir is filled with formalin methanol solution, which is dispensed through the atomizer. See paragraph A57 for the required amounts of formalin solution to be used.

d. Effectiveness. In an open room, the mist from the atomizer should not be expected to be effective for more than 30 ft from the point of discharge.

e. Limitation. One limitation of the atomizer is that it can be used to decontaminate only small areas.

f. Shipment. The portable fumigant atomizer is shipped in a wooden box that weighs 20 lb and occupies 1.5 cu ft.

g. Reference Publication.

See the instruction manual that is issued with the equipment.

Figure A-56. Portable Fumigant Atomizer, 3-gph

APPENDIX B

PLUTONIUM MONITORING

AND

DECONTAMINATION ASHORE

APPENDIX B

PLUTONIUM MONITORING AND DECONTAMINATION ASHORE

Section 1. INTRODUCTION

B1.1 SCOPE

This Appendix pertains to the radiological situation that may result from an accidental detonation or fire that involves plutonium in either land or water areas ashore. The accident that is presumed to occur is the result of fire, shock, or other cause while plutonium is in storage or in transit. The product that is dispersed by blast or fire is a dust or a smoke that includes plutonium oxide (PuO_2). This Appendix includes information on (a) the effects of nuclear contamination on damage control operations, (b) the safety of personnel, and (c) the development of plans and procedures for determining and recovering contaminated areas. The standard disaster control organization that is prescribed in the United States Navy Passive Defense Manual, OPNAV INSTRUCTION 3440.6, and United States Navy Passive Defense Recovery Plan, (PDRP), OPNAV, should be utilized. Only necessary modifications to these instructions are indicated herein.

B1.2 DETERMINATION OF HAZARD

In any accident that involves the destruction of nuclear ordnance, immediate tests should be made to determine whether or not there is any beta-gamma contamination hazard evident. If such a hazard exists, appropriate tolerances, as determined by paragraph 19142, United States Navy Precautions, OPNAV 34P1, and monitoring and decontamination procedures, as prescribed in Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13, Interim Revision, 16 April 1958, and elsewhere in this publication, should be used. Plutonium contamination is a negligible hazard to personnel in comparison with beta-gamma contamination. The rotation of personnel should be utilized to minimize exposure to gamma radiation when it is present. Table B-1 contains a comparison of the problems that are associated with the plutonium hazard following a nuclear weapon accident with the problems that result from fallout from a nuclear explosion.

TABLE B-1

Comparison of Problems Resulting from Accidents with Plutonium and Fallout of Fission Products

Problem compared	PuO_2 Contaminant	Fallout
Principal radioactivity	Alpha particles	Gamma radiation
Penetration	Nearly zero	Extremely high
Shielding	Sheet of paper (100%)	3-in. concrete reduces 50%
Decay	None (half-life is 24,300 years)[1]	Very rapid initially (1/50 from H + 1 to H + 24)
Personnel hazard	Internal only; principally through inhalation	Internal, external, or dangerous even without contact
Working hazard	None with protective gear	Gamma hazard not reduced by protective gear
Monitoring	Very slow; adequate instruments not available	Rapid, reliable means available
Decontamination	Detailed procedures are the same as for fallout except for disposal	Detailed procedures available

[1] PuO_2 contaminant will reduce with time, not by decay, if the very fine contaminant is spread by wind over a much larger area. For example, this "migration half-life" is approximately 100 days in the Nevada desert.

B2.1 BASIC DATA

1. Characteristics of PuO_2 Contaminant.

(1) Plutonium that is involved in an HE explosion becomes molten and burns; also in a sufficiently hot fire, plutonium burns, much like magnesium. The product in either case consists of fine particles of PuO_2. Such PuO_2 is essentially insoluble in water, has practically no decay with time (its half-life being 24,300 years), and is of varying particle size but so fine that it can be carried as smoke or resuspended, even though it clings to the other finely divided materials that are involved in the fire or explosion. This combination of materials is referred to herein as the "PuO_2 contaminant" or simply the "contaminant."

(2) PuO_2 emits alpha particles that have a short range in air (the maximum range being approximately 1-1/2 in.) and are stopped by such thin materials as a coat of paint or a sheet of paper. The hazard to personnel is principally from inhalation (the significant size range is 0.1 to 10 microns), but the relative hazard from ingestion or entry through cuts is considered negligible; nevertheless checks should be made and due precautions should be taken. The contaminant particle size that presents the greatest hazard is so fine that it can be resuspended in an aerosol that is invisible to the naked eye, although it may sparkle in sunlight. The minute size of this contaminant can not be overemphasized, and it must be borne in mind that this hazard may exist even though the contaminant can not be seen.

(3) Finely divided particles of PuO_2 contaminant are deposited over large areas by normal or by rain or dew-induced settling out. The contaminant is difficult to detect (monitor) and to eliminate (decontaminate) as a hazard. The difficulty in detection is due to the lack of adequate instruments and the necessity for holding instruments very close (approximately 1/16") to the dust; the intermixing of soil, the roughness of the pavement, and vegetation cause erroneously low readings in relation to the dust quantity per unit area; and several layers of contaminant particles, which is invariably the way the contaminant is found, will give meter readings that indicate quantities lower than those actually present. This phenomenon is termed "self-absorption."

2. Personnel Protection.

a. Clothing. Complete protection against the highest levels of alpha hazard that may be expected from accidents that involve the PuO_2 contaminant is afforded by a well-fitted respirator or standard protective mask and also dust-tight, disposable, protective outer clothing to facilitate the decontamination of personnel and the disposal of the PuO_2 contaminant on clothing. Where weather conditions permit, personnel may undress and then wear only disposable clothing that is not dust-tight, such as coveralls, boots, gloves, and caps. It may not be necessary to dispose of clothing until the end of all field work, or possibly not at all if adequate, controlled cleaning or laundering facilities are available. (See paragraph 7 of B2.5.)

b. Other Precautions. Eating, drinking, and smoking must be forbidden in any hazardous area where personnel are required to wear respirators. Personnel who are caught in a hazardous area where respirators are not available should hold a folded handkerchief, or some similar protection, over the nose and mouth. It is advisable for all personnel to remain in closed homes or buildings for some time after an accident to avoid contact with the dusty atmosphere, which may contain invisible contamination.

3. Hazardous Concentration Level.

a. Alpha Hazard Level. The alpha hazard level concerns unmasked personnel, where unrestricted movement is allowed. The contaminant is not a significant hazard as long as it does not become airborne. The important factors are both the degree of contamination and the extent to which the material is bound to the surface. The level of the alpha hazard is the quantity and location of the contaminant in the air that will create an inhalation hazard. The quantity of the contaminant in the air may be caused by the original fire and/or HE detonation or it may be the result of resuspension from winds and movement of vehicles or personnel. (See paragraph 3 of B2.2.) The resuspension in the air is the chronic, or long-term, hazard.

b. Safety Criteria. No standard equipment is available for use in the field to measure the hazardous quantity of the contaminant in the air; however, studies have been made to establish the conservative surface concentrations of PuO_2 in a contaminant that may yield an airborne inhalation hazard. These surface concentrations, where the contaminant is spread uniformly on a smooth, flat surface, are described in the following paragraphs.

(1) If the contamination level of PuO_2 is less than 1,000 micrograms per square meter ($\mu g/m^2$), decontamination is not considered necessary, but it should be effected to as low a value as possible, consistent with reasonable efforts and costs, that is, inexpensive decontamination methods.

(2) If the contamination level of PuO_2 is greater than 1,000 $\mu g/m^2$, decontamination should be effected by conventional methods, such as high-pressure hosing or leaching. (See paragraph B2.5 and Tables B-2 and B-3.) A contamination level of 2,000 $\mu g/m^2$ after decontamination (which indicates the removal of the lightly bound and respirable contaminant) should be generally no more hazardous than 1,000 $\mu g/m^2$ untreated. (A contamination level of 2,000 $\mu g/m^2$ is equivalent to alpha readings of 28,000 disintegrations per minute per square centimeter for contaminant that is spread uniformly on a smooth, flat surface.)

(3) If the contamination level of PuO_2 is greater than 2,000 $\mu g/m^2$ after at least two thorough decontamination operations, the situation must be evaluated on an individual basis. (See paragraph B4.1.) The problem is a long-term one, rather than an immediate one, because the lightly bound and respirable contaminant, that is, the hazardous kind, will certainly have been removed.

c. Application of Criteria. The foregoing safety criteria have been developed primarily for application to residential areas that are occupied by non-Government civilian personnel. If only military personnel and/or civilian Government employees are involved, these safety criteria, although they are indicative of the hazard, may not necessitate immediate decontamination or other drastic action because evacuation and other measures may be taken by the local commander.

B2.2 PREDICTED HAZARDOUS AREA

1. Gross Area. The size and shape of the area that will be contaminated as the result of an unconfined, or nearly unconfined, accident that involves PuO_2 will vary with meteorological conditions and the terrain, but a preliminary estimate of the contamination is necessary to define an initial control area, or a predicted hazardous area. An accident with PuO_2 may contaminate an area up to 0.025 square mile, or 16 acres, in one explosion, and the extent of the contamination may be to and above the hazardous concentration level. (See Section 2, paragraph 3b of B2.1.)

2. Area Shape. If at the time of the explosion there is a wind of 0 to 5 knots, a circular area with a 500-ft radius around the explosion center should be considered hazardous. The upwind semicircular area should be retained for all wind conditions, but the downwind semicircular area should be changed to a semi-ellipse with a minor axis radius of 500 ft and a major axis radius varying with the wind velocity as follows: 6 to 10 knots, 2,000 ft; 11 to 15 knots, 3,000 ft; 16 to 20 knots, 4,000 ft; and above 20 knots, 1 mile (statute). The actual critical area will be determined by monitoring. This may vary from the assumed area.

3. Changes in Area. The foregoing predicted area may be modified by more rapid precipitation of the PuO_2 contaminant caused by rain or dew, or by resuspension of the dust through wind-devils and eddies, higher winds, wind currents caused by the movements of personnel and vehicles, and the carrying of dust on tires and human or animal feet, as well as by water migration. Accordingly, dust control measures should be promptly instituted within the predicted hazardous area. (See paragraph B2.4.)

4. Area Control. It is imperative that immediate action be taken to evacuate from the predicted hazardous area all personnel and animals that are caught in the open and to establish police perimeter control, with processing stations located at each access point. However, where buildings have not been breached, personnel and animals do not need to be evacuated if they remain indoors. All personnel in the area must be identified and tagged.

B2.3 MONITORING

1. General. The "predicted" hazardous area can be corrected to an "actual" hazardous area by monitoring. The first corrective work to determine the actual hazardous area should be to establish a map contour that approximates the limits of the hazardous concentration level area that is described in paragraphs 1 and 2 of B2.2. The limits should be determined by using as many point readings as may be necessary, but the four most important readings are those that are taken directly downwind, upwind, and at two crosswind points from the point of detonation. These four readings make the first gross correction of the predicted area shape. The first monitoring at the site should be to check for the presence of beta-gamma hazard. Other monitoring work should include the locating and marking of "hot spots," some of which could be outside of the actual hazardous area, as well as monitoring

to check the effectiveness of the decontamination procedures. Applicable data contained in the text of this publication and the Navy Training Film series MN7984 should be utilized.

2. Monitoring Survey Team. Although the training of personnel and the lack of some equipment items will pose some problems in the early establishment of the monitoring survey teams, personnel and equipment of the NRDL/EODTC Team will help until such inadequacies are corrected. (See Section 4.) The local monitoring team corresponds to the ABC Survey Team that is described in the U. S. Navy Passive Defense Manual, OPNAVINST 3440.6. It is recommended that at least four teams be made available.

a. Personnel. Personnel should include one driver-communicator, one recorder, one alpha monitor, and one beta-gamma monitor. The latter may prove to be unnecessary.

b. Equipment. Equipment should include two (three if possible) alpha radiacmeters, a beta-gamma low-range radiacmeter, a gamma high-range radiacmeter, a radio communication set, protective gear and a low-dose self-indicating (pocket) dosimeter for each person, marking equipment, and miscellaneous gear. In the absence of a beta-gamma hazard, the beta-gamma monitor may be used as a second alpha monitor. The third alpha radiacmeter is a spare.

(1) The alpha radiacmeter should read at least to 14,000 dpm/cm^2, or preferably to 28,000 dpm/cm^2. (See Section 2, paragraph 3b(2) of B2.1.) The top reading for the current Navy instrument, AN/PDR-10D, is 10,000 dpm/150 cm^2 or 67 dpm/cm^2, which is inadequate for survey use here. However it can be "jury-rigged" for the purpose (see Appendix A, paragraph A11) and, in any event, it may be useful for personnel and materiel monitoring. Initially monitors must depend upon special instruments that are carried by the NRDL/EODTC Team.

(2) Appropriate beta and gamma instruments are as follows: (a) low-range beta-gamma radiacmeter, AN/PDR-27G; (b) high-range gamma radiacmeter, AN/PDR-18B; and (c) low-dose self-indicating (pocket) dosimeter, IM-9D/PD or equivalent.

(3) Protective gear should meet the requirements indicated in paragraph 2 of B2.1. Marking equipment should include atomic warning signs, marking crayons, stakes, nails, rope, road barricades, and related equipment. Miscellaneous gear should include hand tools, field rations, and spare gasoline.

3. Monitoring Techniques.

(1) To monitor personnel and vehicles for PuO_2 contamination, the monitoring techniques for fallout radiation hazards should be used, augmented by the use of an alpha radiacmeter as described elsewhere in this publication and in Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13.

(2) To monitor areas for alpha hazard contamination, the techniques to detect fallout hazards should be used as described elsewhere in this publication and in Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13. These techniques will probably be satisfactory for paved areas only, but they should provide sufficient contour points to fairly define the actual hazardous area. To monitor unpaved areas, soil-sampling and laboratory techniques (that is, the "wipe" technique) will probably be necessary, and these techniques are expected to be provided by the NRDL/EODTC Team.

(3) To monitor buildings and structures, the techniques used for paved surfaces are generally used. Exteriors should be carefully checked for contaminant concentrations in areaways, crevices, corners, and on leeward sidewalls and along foundations. A repetition of monitoring may be required by changes of wind direction and/or wind velocity, or it may be required because of the migration half-life. (See footnote to Table B-1.) Interiors of buildings and structures should be similarly checked, plus a careful check of ventilation systems and filters.

(4) Records and Reporting. The recording and reporting techniques that are prescribed for recording and reporting fallout radiation hazards should be used. However, if no gamma hazard is found, the recording of personnel gamma exposure and the interpolation of radiation readings to reference time (that is, H = 1 hour) are eliminated.

B2.4 DUST CONTROL MEASURES

Immediately after a PuO_2 explosion, it is extremely important to promptly institute dust control measures to prevent the resuspension and transport of the contaminants. (See paragraph 3 of B2.2.) Wetting-down with water, covering the area with wet sand or wood shavings, or the use of special compounds that absorb the moisture from the atmosphere (calcium chloride) are a few of the methods used to effect immediate, temporary dust control. Some measures may make later decontamination more difficult. The use of dust

control measures allows more time for the usually slow decontamination methods.

B2.5 DECONTAMINATION

1. General. The decontamination methods for PuO_2 are similar to those used for fallout, the principal difference being that the PuO_2 contaminant must be contained and/or gathered for controlled disposal. Table B-2 briefly describes many decontamination methods. Additional detailed information on personnel, equipment, and the rate of coverage in connection with the application of fallout decontamination methods may be found in Radiological Recovery of Fixed Military Installations, NAVDOCKS TP-PL-13. The following paragraphs in this Appendix contain only information in addition to that in Tables B-2 and B-3. The effectiveness of decontamination can be only very grossly estimated because of the lack of working experience with this contaminant. It is necessary to monitor after each decontamination application to measure its effectiveness and to determine the need for a repetition and/or application of the same or another method of decontamination. If an alpha radiacmeter with a probe is not available, it may be necessary to use laboratory monitoring techniques to check the effectiveness of the decontamination on irregular surfaces. Many decontamination problems can

TABLE B-2

Decontamination Methods

No.	Method	Equipment or operation
1	Firehosing[1]	Using 1-1/2" firehose from hydrant or pumper.
2	Hosing[1]	Using garden hose from standard hose bib.
3	Scrubbing[1]	Water and street broom, long-handled or hand scrub brush.[2]
4	Swabbing[1]	Water and swab (mop) or hand rags.[2]
5	Dip and rinse[1]	Water-dip in pan or tank then clean-water rinse.[2]
6	Motorized flushing[1]	Using standard street flushing vehicle.
7	Motorized sweeping	Using street sweeper, preceded by sufficient wetting to stop resuspension.
8	Pavement sealing	Sealcoat with liquid asphalt, tar, or oil.
9	Paving	Add course of asphaltic or portland cement concrete.
10	Asphalt planing	Special machine heat-softens and windrows top layer.
11	Scraping	Using dozer, grader, or tractor and scraper to remove top layer after wetting-down.
12	Soil covering	Covering with new soil, or burial through plowing, discing or rototilling equipment.
13	Soil stabilization	With equipment and oil, asphalt, portland concrete, or chemicals.
14	Sealing	With paint, sealer, plastic, or wallpaper.
15	Sandblasting	With standard equipment but only wet method.
16	Vacu-blasting	With standard equipment and techniques.
17	Stripping	Sanding, paint removal, wax removal, and refinishing.
18	Steam cleaning[1]	Using equipment such as garage steam jenny (requires control of aerosol hazard).
19	Hot liquid jet[1]	Using equipment such as that used for motor or aircraft cleaning.
20	Vacuuming	Using modified standard vacuum cleaners.[3]
21	Plating	Covers removal and/or replating, electrolytic, or dip.
22	Special cleaners	Such as in-place upholstery and rug cleaning methods and carbon tetrachloride.
23	Laundering and dry cleaning	Self-explanatory, but see paragraph 7 of B2.5.
24	Flocculating	Water treatment precipitation method using chemicals.
25	Strippable materials	Apply material, then remove with contaminant imbedded.[4]

[1]May require water (liquid) control measures. (See paragraph 4 of B2.5.)
[2]With or without laundry detergents, that is, TSP (tri-sodium phosphate); soaps not particularly good.
[3]Contaminant constituting greatest hazard will pass through standard vacuum cleaner bags (see paragraphs 1 (1) and (2) of B2.1); modify with special filter.
[4]Materials include standard strippable coating (FSN G-8030-275-8094); adhesive tapes of all kinds: cellophane, masking, first-aid, and electrician's.

TABLE B-3

Decontamination Applications

No.	Application	Methods (See Table B-2)
1	Paved areas	Consider methods 1 through 3 and 6 through 10, or combinations; that is firehosing/scrubbing/firehosing.
2	Unpaved areas	Consider methods 9 and 11 through 13; see paragraph 5 of B2.5.
3	Building exteriors	Consider methods 1 through 4, 14 through 19, and 25.
4	Building interiors	Consider methods 2 through 4, 14, 16 through 18, 20, and 25.
5	Heating and air conditioning systems	Wash intakes, replace filters, and vacuum throughout system as required.
6	Furniture and furnishings[1]	Consider methods 3 through 5, 14, 17, 20 through 23, and 25.
7	Appliances[1]	Consider methods 3 through 5, 14, 17 through 22, and 25; give special attention to nonimmersible electrical parts.
8	Personnel effects[1]	Consider methods 3 through 5, 20, 22, 23, and 25.
9	Foodstuffs[1]	Use methods 3 through 5 for canned and bottled items (re-mark if label comes off); swab packaged items with damp cloth; dispose of other items in accordance with paragraph B2.6.
10	Vehicles, mechanical equipment, and watercraft	Consider methods 1 through 5, 14, 17 through 22, 25, and car wash facilities.
11	Trees and shrubs[1]	Flush down with fire or garden hose or remove.
12	Storm and sanitary sewers	Reduce the need for decontamination by filtering the input at the source or enroute. For ditches; leach, pave, scrape, or install pipe and cover over; flush pipes; flocculate and clean catch basins.

[1]Replacement may cost less than decontamination.

be handled and the application techniques and dust control measures can be performed for the Navy by the District Public Works Officer with his staff and resources.

2. Criteria. Plutonium decontamination criteria have been established by the Joint Board on Future Storage of Atomic Weapons. These criteria can be summarized as follows.

Condition A: Contamination present in any amount.

Action: Decontamination required consistent with reasonable effort and cost with the use of conventional methods.

Condition B: Contamination present in amounts less than 2,000 $\mu g/m^2$ after decontamination.

Action: No further decontamination required.

Condition C: Contamination present in amounts greater than 2,000 $\mu g/m^2$ after decontamination.

Action: Situation evaluated on an individual basis.

Figure B-1 presents a flow chart that shows the three conditions listed above and indicates the choice of the course of decontamination action to be taken. Under Condition A there are two possible courses of action. If the general level is less than 2,000 $\mu g/m^2$, a Class I decontamination procedure is recommended; where the general level is greater than 2,000 $\mu g/m^2$, a trial of Class I and Class II procedures is recommended to determine which procedure will produce the required results.

Either Condition B or Condition C will exist after decontamination has been accomplished. If the general level is below 2,000 $\mu g/m^2$, no further decontamination is required because the initial decontamination should have removed the particles that are susceptible to resuspension and the remaining contamination should present no hazard. If the general level is greater than 2,000 $\mu g/m^2$ after decontamination, Class III procedures may be required. The decision to conduct further decontamination in Condition C will depend on such factors as the ultimate use of the area, the ownership of the area, the cost of decontamination versus the cost of replacement, the feasibility of utilizing continuous air monitors as a control function, and other pertinent factors.

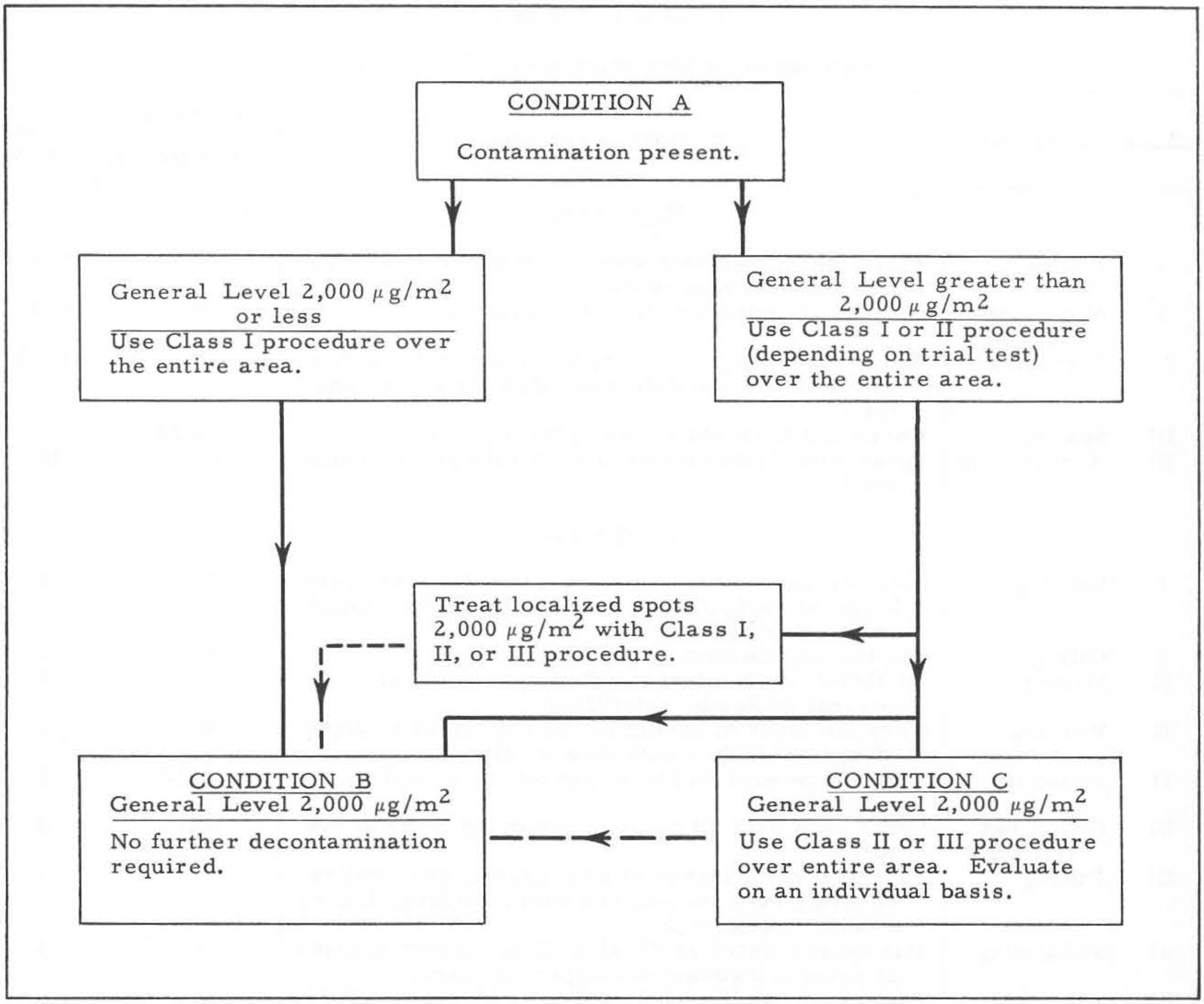


Figure B-1. Plutonium Decontamination Flow Chart

TABLE B-4 indicates the recommended decontamination procedures for the various components of a built-up area that may become contaminated with plutonium. The procedures are separated into three classes as follows.

(1) Class I procedures are generally those that are most readily available and can be performed at relatively low cost.

(2) Class II procedures are those that require more effort and are more effective than Class I procedures.

(3) Class III procedures are those that involve surface removal techniques or complete sealing and, by their very nature, are costly and time consuming.

Considerable research has been directed toward the development of procedures for the removal of fallout that results from nuclear detonations. The same procedures are believed adequate to meet the plutonium contamination (Plucon) problem. However, the procedural performance may not coincide with that normally expected when dealing with nuclear weapon debris, because of the gross differences in the chemical and physical characteristics and the quantity of fallout.

3. Personnel Decontamination. The methods for the decontamination of personnel after a PuO_2 accident are similar to those for decontamination after fallout except that all clothing containing the contaminant may have to be destroyed. (See paragraph 6 of B2.5 and paragraph B2.6.) In addition, the control of

TABLE B-4 (1 of 2)

Recommended Decontamination Procedures

Class	Procedure	Principle of operation	Planning rate (1,000 ft^2/hr)	No. of men
		Paved areas		
I	Hosing	Flush thoroughly with streams of water. 1-1/2-in. fire hose recommended.	15	6-8
I	Motorized flushing	Clean with conventional street flusher.	35	1-2
II	Scrubbing	After flushing by one of the above methods, scrub with brushes and detergent, then flush a second time.	10	11-13
III	Sealing	Cover and fix contaminant to the surface.	0.75	2
III	Resurfacing	Spray with liquid asphalt and top with gravel and/or sand.	25	10
		Land areas		
I	Soaking	Saturate with water from fire hydrants, road sprinklers, or irrigation systems to leach the contaminant below the surface.	30	1
I	Oiling	Fix the contaminant with oil spray.	40	2
II	Mixing	Distribute contaminant uniformly to depth of several inches by rototilling.	3	1
II	Burying	Turn top layer of contaminated soil under to depth of several inches with plow or disc.	30	1
II	Stripping	Remove several inches of top soil by scraping, bulldozing.	2-12	1
III	Oiling and stripping	Spray area with oil prior to removing layer of top soil	2-12	3
III	Filling	Spread several inches of soil, gravel, and similar covering over the surface with scrapers, dozers, or other equipment.	3-10	1
III	Stabilizing	Mix contaminated earth with oil or cement to depth of several inches and compact in place.	1	4
III	Surfacing	Spray with liquid asphalt and top with gravel and/or sand.	25	10
		Structural exteriors		
I	Hosing	Flush down roofs and walls with streams of water.	2.5	2
II	Scrubbing	Flush, scrub with brushes and detergent, and flush again.	2.5	5
III	Sealing	Cover and fix the contaminant to the surface by painting.	0.75	2
III	Stripping	Loosen paint with caustic compound and remove by hosing.	1	3
		Structural interiors and furnishings		
I	Vacuuming	Pick up and entrap contaminant with vacuum cleaner.	0.5	2
I	Swabbing	Pick up contaminant with mops and rags soaked in detergent or mild chemical agents.	0.5	1
I	Dipping	Dip items in detergent, solvent, or chemical solutions.		1-3
I	Laundering	Standard procedure under controlled conditions for clothing and fabrics.		1-3

TABLE B-4 (2 of 2)

Class	Procedure	Principle of operation	Planning rate (1,000 ft^2/hr)	No. of men
		Structural interiors and furnishings--Continued		
I	Special cleaning	Lift dirt and contaminant out of rugs and upholstery with solid chemicals or dry foam cleaners.		1-3
II	Sealing	Cover and fix contaminant to the surface by painting.	0.75	1-3
III	Resurfacing	Remove and replace wax, paint, varnish, and other surfaces in normal manner.	0.25	1-3
III	Sanding	Remove outer surface layer with standard sanding machine.	0.25	1
III	Removal	Dispose and replace.		
		Vehicles, machinery, and equipment		
I	Washing	Flush, scrub with detergent, and rinse.		1-3
I	Dipping	Dip in detergent, solvent, or chemical solutions.		2-6
I	Vacuuming	Pick up and entrap contaminant with vacuum cleaner.		1
II	Steam cleaning	Clean with steam (or hot liquid) jet containing suitable additives.		2
II	Degreasing	Coat with "gunk" and rinse.		2
III	Stripping	Loosen paint with caustic compound and remove by hosing or dip rinsing.		3
III	Sand blasting	Remove outer surface layer with standard sand blasting equipment.	0.03-0.1	2
		Special problems		
		Trees		
I	Hosing	Sprinkle foliage with low-pressure stream. Fog nozzles ideal.		1-3
II	Fixing	Spray with sealing agents (paint, lacquer, or oil) to lock contaminant to foliage.		2
		Stock piles		
I	Hosing	Flush down with streams of water.		

shower water may be necessary, and is described in the following paragraph. Medical guidance will be required if there are any breaks in the skin or any indication that the contaminant may have entered a body opening.

4. Water Control. If it is considered necessary to prevent the uncontrolled movement of the PuO_2 contaminant out of the controlled area, the water from showers, from pavement washing, from laundering, rain and snow, and any other water must be filtered or collected in a settling area, such as a dammed-off section of drainage ditch or stopped-off manhole, to allow sedimentation whereby the contaminant may be collected. If this is impossible, water areas may become contaminated and the problems discussed in Section 3 of this Appendix will be created.

5. Unpaved Areas. Wetting-down, rain, or snow will carry the contaminant into the soil (leaching), and thus reduce or even eliminate the present hazard. Because erosion, plowing, earth-moving, or other soil disturbances may later re-establish the hazard, periodic monitoring checks are necessary. The use of liquid asphalt, tars, or oils will prevent the resuspension of the dust and keep it near the ground surface for removal.

6. Building Interiors. The usual means of cleaning the interior of a building, such as vacuum cleaning and scrubbing, are appropriate, but the extreme care that is required to collect the contaminant and the need for digging out every nook and crevice can not be overemphasized.

7. Laundering and Dry Cleaning. Approximately 90% of the contaminant will be removed by the standard laundering and dry cleaning methods, but the water or cleaning solution will have to be filtered or changed frequently and disposed of in accordance with paragraph B2.6. The cost of recovery under such conditions may exceed the replacement cost.

B2.6 DISPOSAL OF CONTAMINANT AND CONTAMINATED REFUSE

The decontamination methods described in paragraph B2.5 either (a) imbed the Pu/PuO_2 dust by burial or sealing or (b) collect it, possibly intermixed with soil, tar, rags, or clothing, through scraping, filtering, or flocculating-cleaning. Only the collection of the contaminant poses disposal problems. It may be desirable to transport the contaminant and/or the refuse to a central storage and processing point to await disposal. The choices for disposal vary, depending on the geography and the regulations of other agencies, such as the AEC and pollution control organizations. For these reasons, the addition of further data is not considered necessary.

Section 3. WATER AREAS

B3.1 INTRODUCTION

The overall problem that is involved in connection with a plutonium accident in water areas is far less serious than that described in the preceding sections in connection with accidents ashore. The problem in water areas will seldom, if ever, be anything other than a long-term one because the hazard is one of inhalation. (See paragraph 1(2) of B2.1.)

B3.2 GENERAL

This section is concerned with open water areas, such as reservoirs, settling basins, ponds, lakes, streams, rivers, canals, and harbors. The coverage is restricted to significant information that differs from that in Section 2. The applicable parts of Section 2 should be utilized.

B3.3 BASIC DATA

Because of its slow settling-out rate in water, the contaminant that strikes moving water surfaces will be carried until the water is considerably slowed or stopped unless flocculation is employed. Resuspension in water is possible because of currents, water agitation created by personnel who are swimming or walking in the water, or by water craft.

B3.4 PREDICTED HAZARDOUS AREA

The surface predicted area must be related to the location of the settled-out contaminant by a study of the water movements that are involved, if any.

B3.5 MONITORING

Monitoring is not considered necessary in water areas, as stated in paragraph B3.1; but if authorities require the monitoring of potable water sources and bathing areas, the suspended contaminant may be detected by the use of a microfilter, by drying and monitoring the residue, or by other laboratory techniques. The contaminated sediment may be detected by bottom-sampling and laboratory techniques. Evaporating a water sample and monitoring the residue will not be satisfactory because of the self-absorption phenomenon described in paragraph 1(3) of B2.1.

B3.6 DECONTAMINATION AND DISPOSAL

The decontamination of water areas and the disposal of the contaminant should not be necessary, as explained in paragraph B3.1, but it may be required to satisfy public authorities. The suspended contaminant may be removed by flocculation or filtering. The contaminated sediment may be handled by dredging, dumping at sea, or depositing ashore for drying-out and handling as an unpaved area. (See paragraph 5 of B2.5.)

Section 4. NRDL/EODTC PLUCON TEAM

B4.1 INTRODUCTION

It is planned that the naval district and similar disaster control teams will soon be adequate to assume the functions currently being performed by the NRDL and EODTC PLUCON Teams.

B4.2 MISSION

The mission of the NRDL/EODTC PLUCON Team is to assist the commander who is responsible for handling a weapons accident as follows.

(1) Augment local teams in radiological monitoring of contaminated areas.

(2) Provide an instrument calibration service and advice on monitoring techniques and interpret the data derived from monitoring and instrument readings.

(3) Specify hazardous and safe areas, based on currently established tolerance levels for surface and airborne contamination.

(4) Provide advice regarding available and desirable methods of decontamination, reclamation, and waste disposal.

(5) Provide information regarding logistic and equipment requirements, the anticipated effectiveness of the various recovery methods and the cost of recovery in terms of time, manpower, and money.

(6) Provide advice and assistance (a) in evaluating the extent of the biological hazard that is incurred by personnel who were exposed prior to evacuation, and (b) controlling and evaluating the biological hazard that was suffered by recovery and reclamation crews during the decontamination operation.

(7) Provide overall advice on optimum methods of handling organizational and operational problems that are associated with decontamination and radiological control of large areas.

B4.3 PERSONNEL

The Team will be composed of the following members.

1. Team Leader. The Team Leader will coordinate all the Team's efforts. He will receive all requests from the commander and will relay to him all finds and opinions of the Team.

2. Radiological Safety Specialist. The Radiological Safety Specialist is qualified to provide advice regarding instrument calibration and to recommend and advise on detailed monitoring techniques and the interpretation of data obtained. He is qualified to specify hazardous and safe areas, in accordance with established tolerance levels. He is qualified to recommend protective measures for all operations.

3. Recovery Specialist. The Recovery Specialist is qualified to advise on available and desirable methods for decontamination, reclamation, and waste disposal. He is qualified to provide information regarding logistic and equipment requirements, the anticipated effectiveness of the various recovery methods, and the cost of recovery in terms of time, money, and manpower.

4. Medical Officer. The Medical Officer is qualified to evaluate the extent of the biological hazards that may be incurred by all personnel, whether they are exposed prior to evacuation or during subsequent monitoring and decontamination procedures.

5. Hospital Corpsman. The Hospital Corpsman will assist the Medical Officer as required.

6. Instrument Specialist. The Instrument Specialist is qualified to calibrate, repair, and maintain the radiacs that are used in the operation.

B4.4 EQUIPMENT

The Team will have its own alpha survey meters and beta-gamma survey meters to augment, to some extent, the supply that is provided by the commander. A detailed list of monitoring equipment is contained in Table B-5.

B4.5 LOGISTIC SUPPORT BY AREA COMMANDER

The area commander should supply the following support for the Team.

(1) Berthing and messing facilities for six men.

(2) Transportation for six men and approximately 2,750 lb of equipment from the point of arrival in the commander's area to the scene of the accident. The equipment will be packed in cases that total about 170 cu ft, with the largest size case being 2 ft by 2 ft by 3 ft.

(3) Field laboratory facilities consisting of two separate spaces of 100 sq ft each. One space will be provided with 30 sq ft of bench or table space; the other space will be provided with 100 sq ft of shelving or other storage space for samples. Electric lights and 2-1/2 KW, 100-volt, 60-cycle, single-phase power source will be required.

B4.6 GEOGRAPHICAL AREAS

The Team from NRDL will assist on accidents that occur west of the Mississippi River; the Team from EODTC will assist on accidents that occur east of the Mississippi River. Each Team will be in readiness status to get under way on four hours' notice.

TABLE B-5

Monitoring Equipment

Quantity	Description
2	Laboratory-type alpha scintillation counters for accurate analyses
3	Technical associates alpha meter (JUNO) Model SRJ-3, for use as a reference instrument for survey meters
10	Eberline gas-flow proportional alpha survey meters, Model PAC-2G, range 0-100,000 dpm, with accessories and spare parts
10	AN/PDR-10 radiac sets: alpha survey meters
4	AN/PDR-18 radiac sets: gamma survey meters
4	AN/PDR-27 radiac sets: beta-gamma survey meters
25	IM-19B/PD radiacmeters: dosimeters, 0-10 r
2	PP-354C/PD dosimeter chargers
23	Check sources and counting standards
25	Staplex air samplers
12	Annular air impactors
2	Wind measuring sets (portable)
	Electronic maintenance and repair equipment, including oscilloscope, Simpson meter, radiopulser, voltage regulators, and tools
50	Contamination signs, metal
100	Contamination stickers
100	Marking stakes
50	Mine marking tapes, 1,000-ft rolls
50	Plastic bags, 2' x 6'
100	Plastic bags, 1' x 2'
200	Plastic bags, 6" x 1'
150	Sample bottles
500	Air sample filters, type 1106B, MSA
1,000	Sample envelopes
60 sets	Protective (rad-safe) clothing, including booties, hoods, caps, coveralls, socks, and underwear
12 pr	Shoes, leather
12 pr	Rubbers
12 pr	Rubber gloves
12 pr	Leather gloves
12	Masks, M9A1
12	Canisters, spare, M11
12 rolls	Masking tape, 2"-rolls
6	Skin decontamination kits
12	Laundry bags

APPENDIX C

PURIFICATION OF WATER CONTAMINATED BY CW AGENTS

APPENDIX C

DECONTAMINATION OF WATER CONTAMINATED BY CW AGENTS

When the supply of water is too heavily contaminated by CW agents to pass the screening test, every effort should be made to secure another natural, noncontaminated source or to have pure water supplied from elsewhere. If pure water is not available, the contaminated water must be treated as outlined briefly below. Only trained water-purification personnel should undertake such procedures.

When large volumes of water are to be treated, the water must be withdrawn from the intermediate levels of the source, with a minimum disturbance of the surface and with no disturbance of the bottom water. A limited amount of contaminated water is pumped into a canvas reservoir and a quantitative analysis made by the responsible officer, using the M4 water testing kit for poisons. The amount of water that can be treated at one time will be governed by the capacity of the pump that is used for recirculation, and the water should not exceed one-half the hourly capacity of the pump.

1. Treatment for Nerve Gas Contamination. For the treatment of large volumes of water that is found to be contaminated with the nerve gases, the following procedure is recommended.

(a) After all the contaminated water that is to be treated at one time is pumped into the treatment tank, the proper amount of soda ash is added by submerging it in a wire basket. The soda ash is added to the contaminated water at the rate of 5 ppm (1/24 lb for each 1,000 gal) for each ppm of nerve gas.

(b) The soda ash and contaminated water are mixed by recirculation to assure the equal distribution of the soda ash. The mixing is continued until tests show that the residual agent concentration is near zero. This will be effected when the pH is above 9. Normally the mixing will require an hour. If the concentration of nerve gas drops too slowly, another dose of 5 ppm (1/24 lb per 1,000 gal) for each ppm of nerve gas should be added.

(c) Alum should be added to reduce the pH for coagulation. Because of the increased pH, a higher dosage of alum than that usually employed for coagulation will be required for a good floc; that is, about 240 ppm (2 lb per 1,000 gal) of alum may be required. Normal procedures and equipment may be used in adding alum and in the coagulation, settling, and filtration of the water.

(d) After filtration, but before chlorination and use of the water, quantitative water tests should conform to the following conditions.

(1) Nerve gas concentration, not more than 0.5 ppm.

(2) The pH, above 5.

(3) Chlorine demand, less than 5 ppm.

(4) No chemical odor or taste.

(e) In the case of "GA" (one of the G-series agents) contamination, aeration of the treated water after chlorination is required to release from the treated water the cyanide gas that was formed by the above treatment. This aeration can be accomplished by recirculation of the treated water through any nozzle that will disperse the stream of water in the air. If sufficient dispersion is not obtained with available nozzles, the stream may be directed against a suitable baffle for additional dispersion. The release of the cyanide gas will require either 1-1/2 hours or 6 recirculations, whichever is the longer. Generally, equipment that can be used to test for cyanide will not be available; however, if the aeration procedure is carefully followed, the treated water will be safe for limited use.

2. Treatment for Arsenicals and Mustard Contamination. For the treatment of large volumes of water that is found by tests to be contaminated with arsenicals and mustards, the following procedure is recommended.

(a) Mix a predetermined amount of activated carbon to provide the doses given in (b) below, with several gallons of water and pump this mixture into the tank and then complete the filling of the tank with the contaminated water.

(b) The contaminated water should be treated with activated carbon (200 mesh) in the following doses.

(1) For lewisite--30 ppm (1/4 lb per 1,000 gal) of carbon for each ppm of lewisite.

(2) For mustard--30 ppm (1/4 lb per 1,000 gal) of carbon for each ppm of mustard.

(3) For nitrogen mustard--60 ppm (1/2 lb per 1,000 gal) of carbon for each ppm of nitrogen mustard.

(c) The carbon and contaminated water are mixed by recirculation to assure the complete adsorption of the chemical agent by the carbon. The mixing time should be either 20 minutes or the time that is required for recirculation of the water twice, whichever is the longer. Hand mixing with paddles in a large tank will not usually give adequate mixing.

(d) After the carbon and the water are mixed, alum and sufficient soda ash should be added for good coagulation. The amount of alum that is required will depend on the pH of the water that is being treated. A requirement of 175 ppm (1-1/2 lb per 1,000 gal) of alum would not be unusual. Regular procedures and equipment for coagulation and settling will be suitable for this operation. Sludge from this operation is contaminated and should be handled as such. It is suggested that this sludge be pumped into a shallow pit and covered with earth.

(e) The supernatant water should then be filtered through the filters at their normal rate, or preferably a little slower. The filtered water should conform to the following conditions before chlorination.

(1) Mustards, not more than 5 ppm.

(2) Lewisite (arsenicals), not more than 20 ppm.

(3) The pH, above 5.

(4) Chlorine demand, less than 5 ppm.

(5) No chemical odor or taste.

APPENDIX D

RADIAC REPAIR FACILITIES

APPENDIX D

RADIAC REPAIR FACILITIES

The following radiac repair facilities have been established by the Chief, Bureau of Ships, to provide maintenance service on radiacs free of charge to end-user activities. Schedules for such service have been established by each facility and may be obtained from the cognizant maintenance activity upon request.

Facility	Area of Radiac Maintenance Cognizance
NAVSHIPYD Boston	All 1st ND and ships (except NavBase Portsmouth)
NAVSHIPYD Portsmouth	NavBase Portsmouth and ships
NAVSHIPYD New York	All 3rd ND and ships (including service to overseas activities)
NAVSHIPYD Philadelphia	All 4th ND and ships
NAVSHIPYD Norfolk	All 5th ND and ships (including service to overseas activities)
NAVSHIPYD Charleston	All 6th ND and ships
INDMAN EIGHT NRLNS	All 8th ND and ships
INDMAN NINE GLAKES	All 9th ND and ships
INDMAN TEN San Juan	All 10th ND and ships
NAVSHIPYD Long Beach	Northern sector of 11th ND and ships
RESINDMAN, 11ND, SDIEGO	Southern sector of 11th ND and ships
NAVSHIPYD Mare Island	All 12th ND and ships (except NSY SFRAN and NRDL)
NAVSHIPYD SFRAN	NSY SFRAN and ships (including NRDL)
NAVSHIPYD Puget Sound	All 13th ND and ships
NAVSHIPYD Pearl Harbor	All 14th ND and ships (including service to overseas activities)
Naval Weapons Plant Washington, D. C.	All PRNC and SRNC and ships
INDMAN FIFTEEN Balboa	All 15th ND and ships
INDMAN SEVENTEEN Kodiak	All 17th ND and ships

Additional information concerning radiac equipment for disaster control purposes is obtainable from the radiac coordinator at each of the activities listed above and from the following instructions:

(1) Priorities of Allowances of Atomic, Biological, and Chemical Warfare Defense Material, OPNAV 04400.4, 7 Apr 55.

(2) Passive Defense Equipment and Material; Responsibilities for, OPNAV 04400.6, 11 Feb 57.

(3) Uniform Maintenance Policy for Radiac Equipment; Establishment of, BUSHIPS 9673.11, 30 Sep 54.

(4) Uniform Maintenance Policy for Radiac Equipment; Guidance on, BUSHIPS 9673.11, Supplement 1, 10 May 55.

(5) Bureau of Ships Manual, Chapter 67.

APPENDIX E

Figures and Tables

APPENDIX E

Figures and Tables

E1. MAXIMUM WAVE HEIGHT VERSUS DISTANCE FROM SURFACE ZERO FOR 1-KT EXPLOSION IN WATER HAVING A SCALED DEPTH OF 85 FT

Figure E-1 shows the approximate maximum crest-to-trough wave height versus horizontal distance from surface zero for 1-KT burst in water having a scaled depth of 85 ft. That is, the actual depth divided by $W^{1/4}$ is 85 ft.

SCALING

At a given distance from surface zero, the wave height for W-KT explosion is $W^{1/2}$ times the wave height at this distance for 1-KT burst in water of the same <u>scaled</u> depth. For water shallower than 85 $W^{1/4}$ ft, the wave height decreases linearly with the depth of water.

EXAMPLE

Given: (a) 30-KT bomb detonated in 200 ft of water.
(b) 30-KT bomb detonated in 100 ft of water

Find: Expected maximum wave height in each case at 4 miles from surface zero.

Solution: (a) Scaled depth of water is $200/30^{1/4}$ or 85 ft. Therefore, Figure E-1 is directly applicable to this case. From the curve, the maximum wave height at 4 miles from 1 KT is 1.0 ft. Therefore, for a 30-KT bomb in 200 ft of water the wave height is

$$1.0 \times 30^{1/2} = 5.5 \text{ ft.}$$

(b) Because 100 ft is less than 85 $W^{1/4}$, when W is 30 KT, the wave height will now be proportional to the actual depth of the water. When the depth is 200 ft, the wave height at 4 miles from the 30-KT burst is 5.5 ft; hence for a water depth of 100 ft, the wave height at the same distance is

$$5.5 \times \frac{100}{200} = 2.7 \text{ ft.}$$

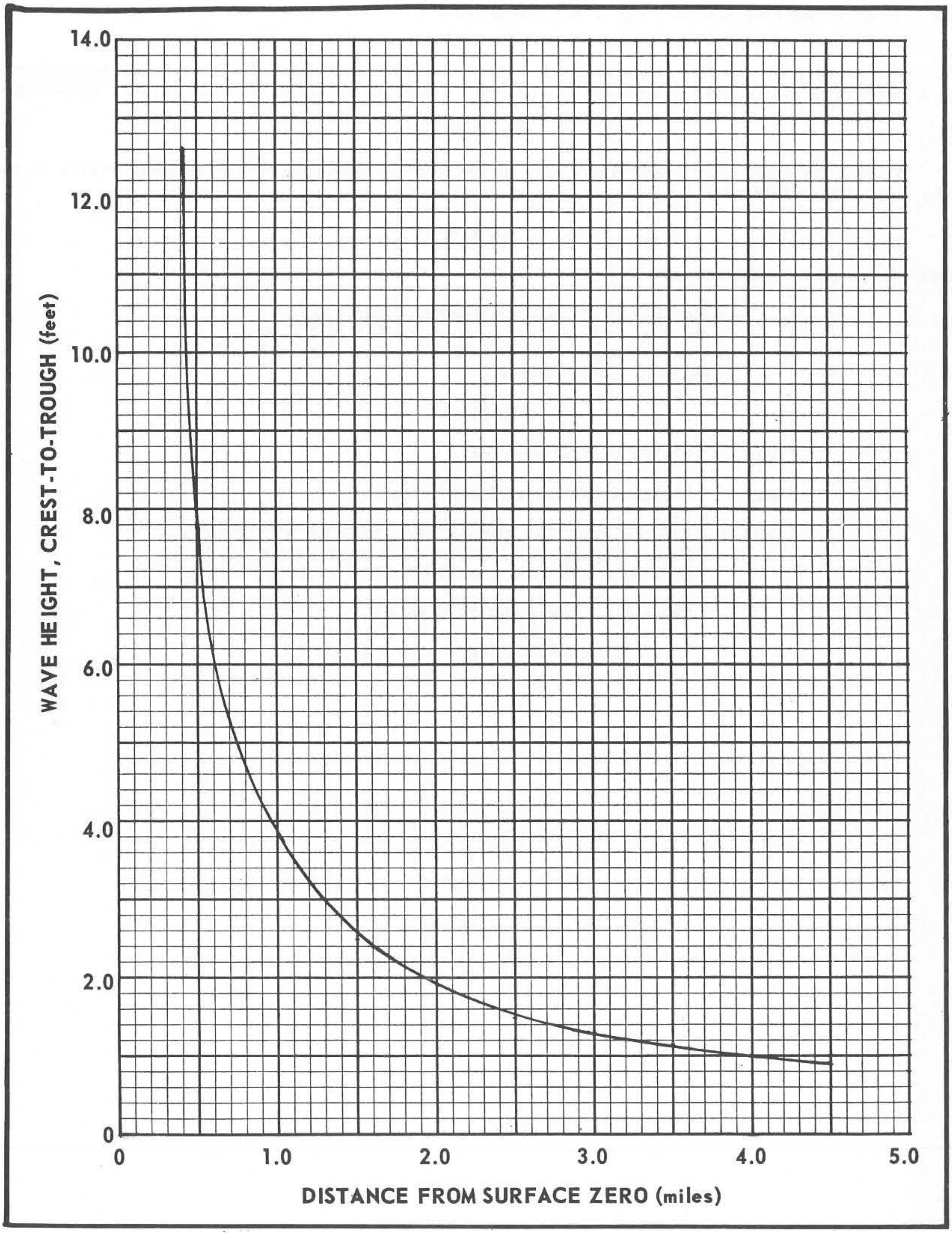


Figure E-1. Maximum Wave Height Versus Distance from Surface Zero for 1-KT Explosion in Water Having a Scaled Depth of 85 ft

E2. PEAK OVERPRESSURE FOR 1-KT AIRBURST

Figure E-2 shows the variation of the peak overpressure with distance from ground zero for a 1-KT typical airburst in a standard sea level atmosphere under average surface conditions.

SCALING

For yields other than 1 KT, the range to which a given overpressure extends scales as the cube root of the yield, W:

$$d = d_o \times W^{1/3}$$

where for a given overpressure

d_o is the distance from the explosion for 1 KT,
d is the distance from the explosion for W KT, and
$W^{1/3}$ is the scaling factor for W KT. (See Figure E-5 for the cube root scaling curve.)

EXAMPLE

Given: 10-MT typical airburst.

Find: Distance to which 25 psi extends.

Solution: From Figure E-5, the scaling factor for 10 MT is 21.5. From Figure E-2, the peak overpressure of 25 psi occurs at a distance of 370 ft from 1-KT airburst.

Therefore, for a 10-MT airburst

$$d = d_o \times W^{1/3} = 370 \times 21.5 = 7{,}945 \text{ ft.}$$

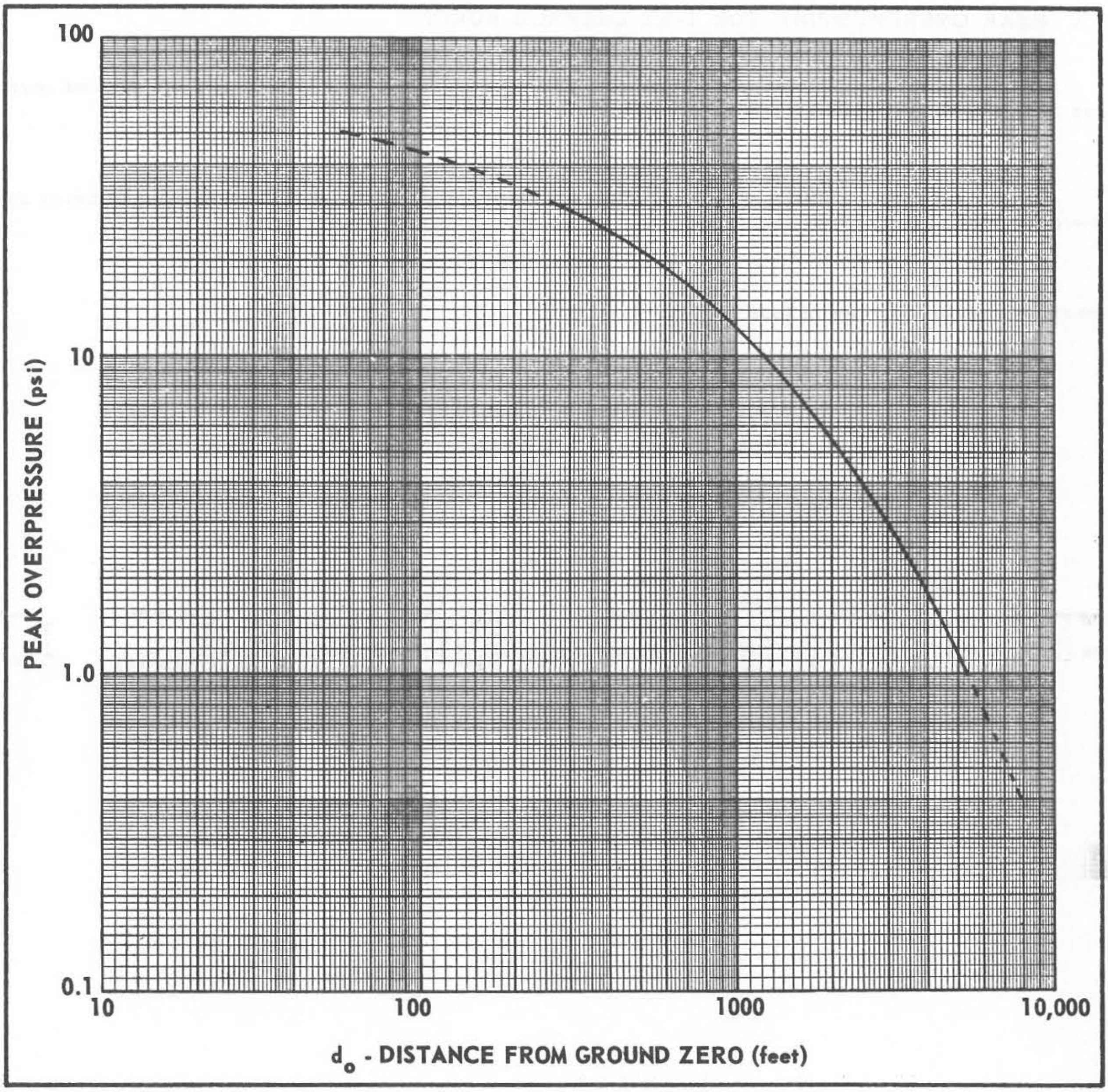


Figure E-2. Peak Overpressure for 1-KT Airburst

E3. PEAK OVERPRESSURE FOR 1-KT SURFACE BURST

Figure E-3 shows the variation of the peak overpressure with distance from ground zero for 1-KT surface burst in a standard sea level atmosphere.

SCALING

For yields other than 1 KT, the distance to which a given overpressure extends varies as the cube root of the yield, W:

$$d = d_o \, W^{1/3}$$

where for a given overpressure

d_o is the distance from the explosion for 1 KT,
d is the distance from the explosion for W KT, and
$W^{1/3}$ is the scaling factor for W KT. (See Figure E-5 for the cube root scaling curve.)

EXAMPLE

Given: 1-MT surface burst.

Find: Distance to the 2 psi contour.

Solution: From Figure E-5, the scaling factor for 1 MT is 10. From Figure E-3, the peak overpressure of 2 psi occurs at a distance of 2,700 ft from the 1-KT surface burst.

Therefore, for a 1-MT surface burst

$$d = d_o \, W^{1/3} = 2{,}700 \times 10 = 27{,}000 \text{ ft.}$$

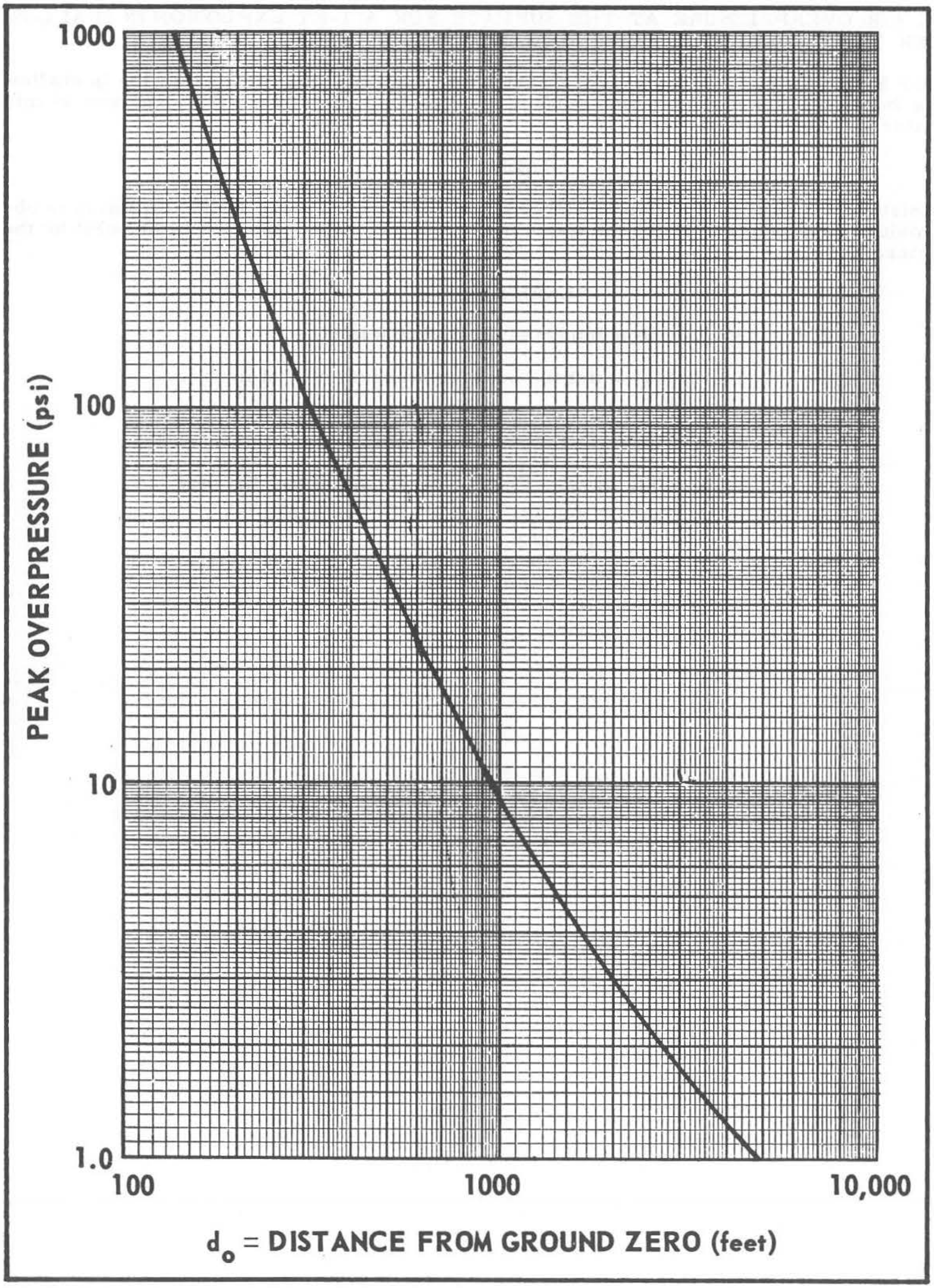


Figure E-3. Peak Overpressure for 1-KT Surface Burst

E4. PEAK AIR OVERPRESSURE AT THE SURFACE FOR A 1-KT EXPLOSION IN SHALLOW WATER VERSUS DISTANCE FROM SURFACE ZERO

Figure E-4 gives the peak air overpressure at the surface for a 1-KT explosion in shallow water as a function of the distance from surface zero. This curve is for 1-KT explosion at mid depth in water that is 66 ft deep.

SCALING

The distance at which a given peak air overpressure occurs for a W-KT explosion is obtained by multiplying the distance for the same overpressure in the case of a 1-KT burst by the scaling factor, $W^{1/3}$.

EXAMPLE

Given: 30-KT bomb detonated in shallow water.

Find: Distance at which the peak air overpressure at surface is 5 psi.

Solution: From Figure E-4, the peak air overpressure of 5 psi will occur at a distance of 0.2 miles from surface zero for a 1-KT burst. Hence, the ground zero distance from a 30-KT explosion for the same overpressure is

$$0.2 \times 30^{1/3} = 0.62 \text{ mi.}$$

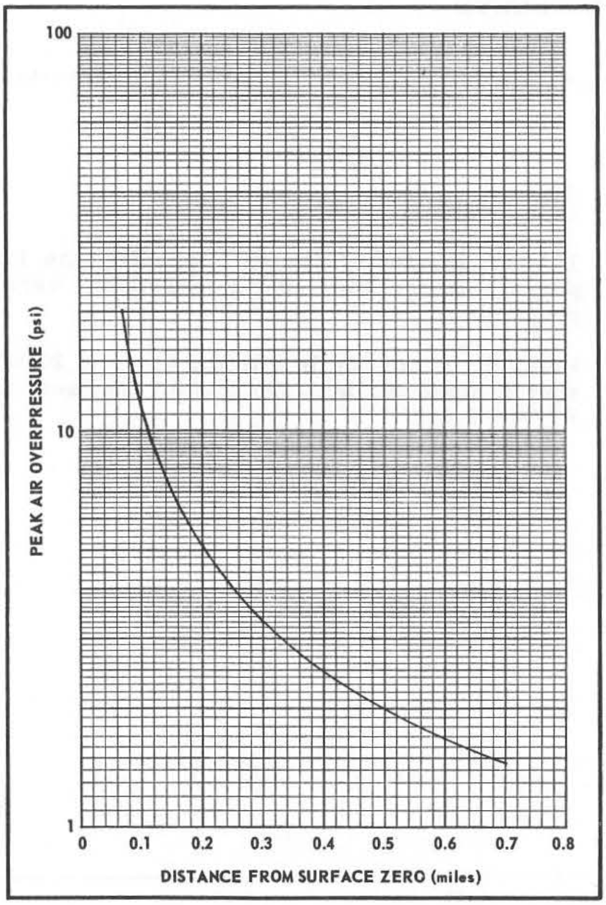


Figure E-4. Peak Air Overpressure at the Surface for a 1-KT Explosion in Shallow Water Versus Distance from Surface Zero

E5. CUBE ROOT SCALING CURVE

Figure E-5 gives the values of cube roots that are required in the application of the scaling laws.

EXAMPLE

Given: 20-KT explosion.

Find: The scaling factor for use in finding the blast wave properties for the 20-KT explosion versus 1-KT properties.

Solution: Enter the scale for W with the value of 20 KT, intersect a diagonal line, and obtain the scaling factor, $W^{1/3} = 2.71$.

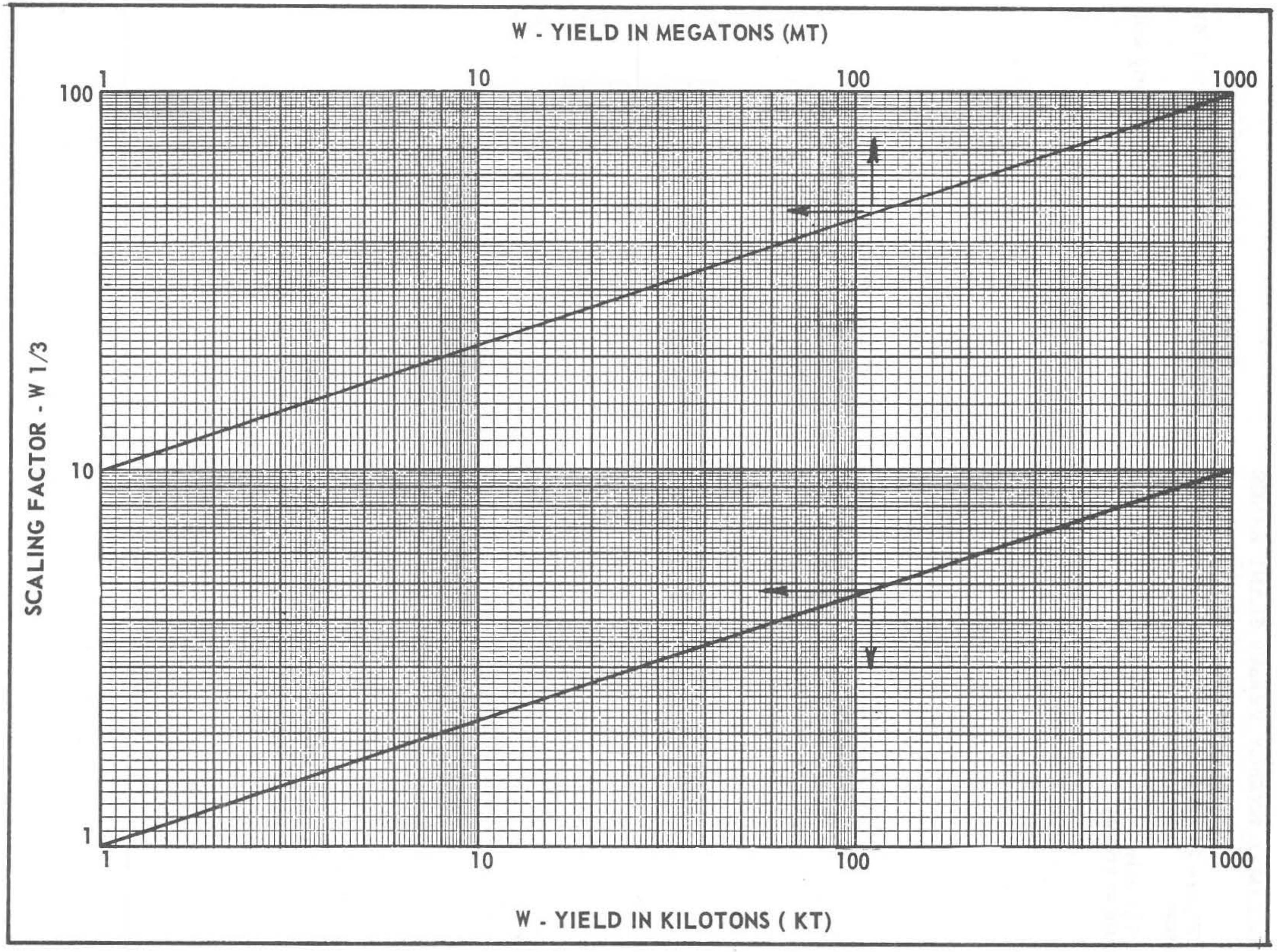


Figure E-5. Cube Root Scaling Curve

E6. THERMAL ENERGY VERSUS SLANT RANGE

Figure E-6 shows the variation of thermal energy with distance (slant range) from a 1-KT explosion.

The unit thermal energy for yields other than from a 1-KT explosion varies directly with the ratio of yields.

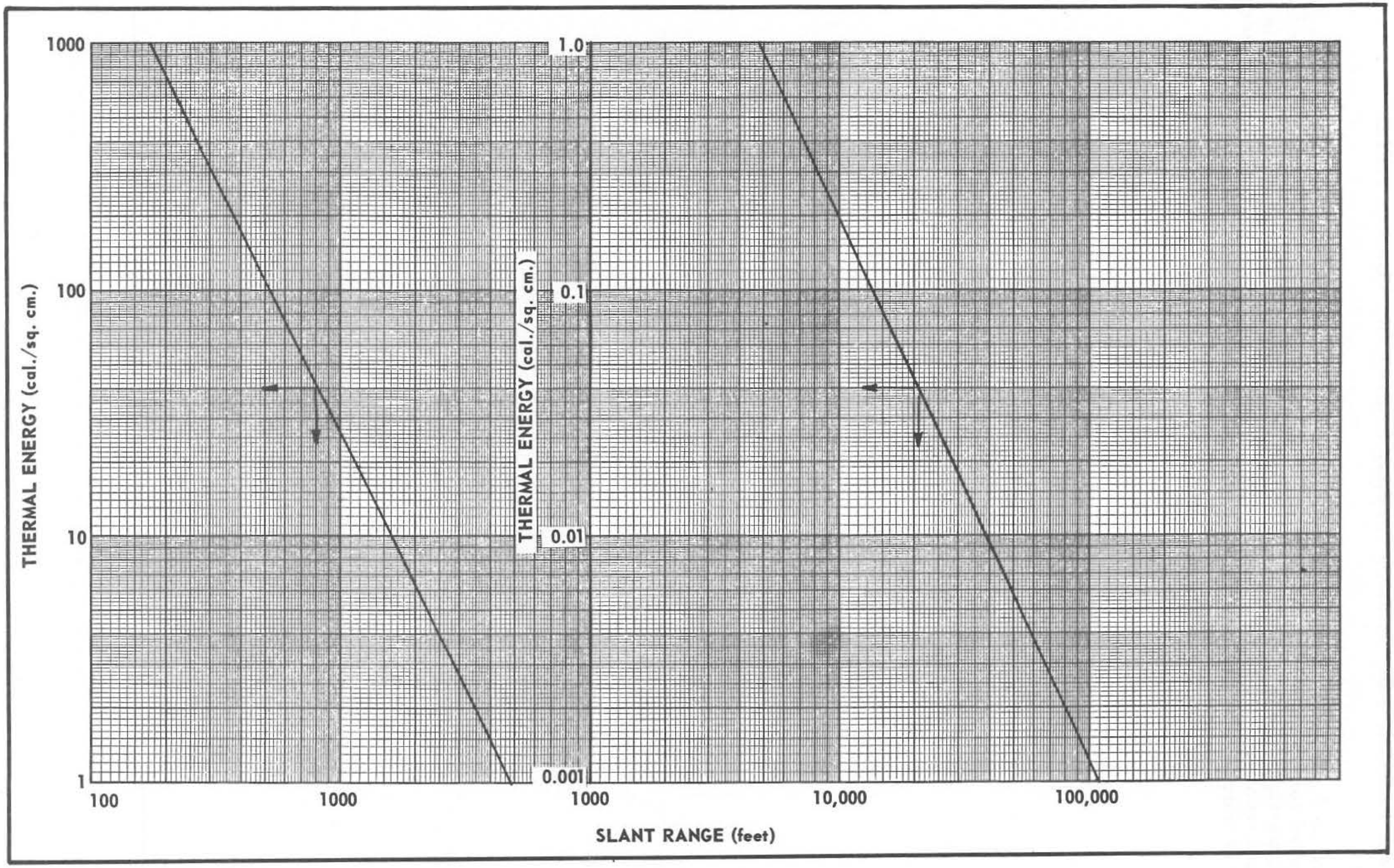


Figure E-6. Thermal Energy Versus Slant Range (1-KT Airburst) 2- to 50-Mile Visibility

E7. SCALING FACTOR FOR INITIAL GAMMA RADIATION VERSUS YIELD

Figure E-7 presents the scaling factor to be used in conjunction with Figure 2-4. The curve is plotted for an airburst. A somewhat lower value of gamma yield will result from surface bursts, particularly from weapons up to 100 KT. The use of the airburst curve for surface bursts is conservative. However, the reduction of gamma yield is not great and, therefore, the slant range at which a given dose will be received is not greatly affected.

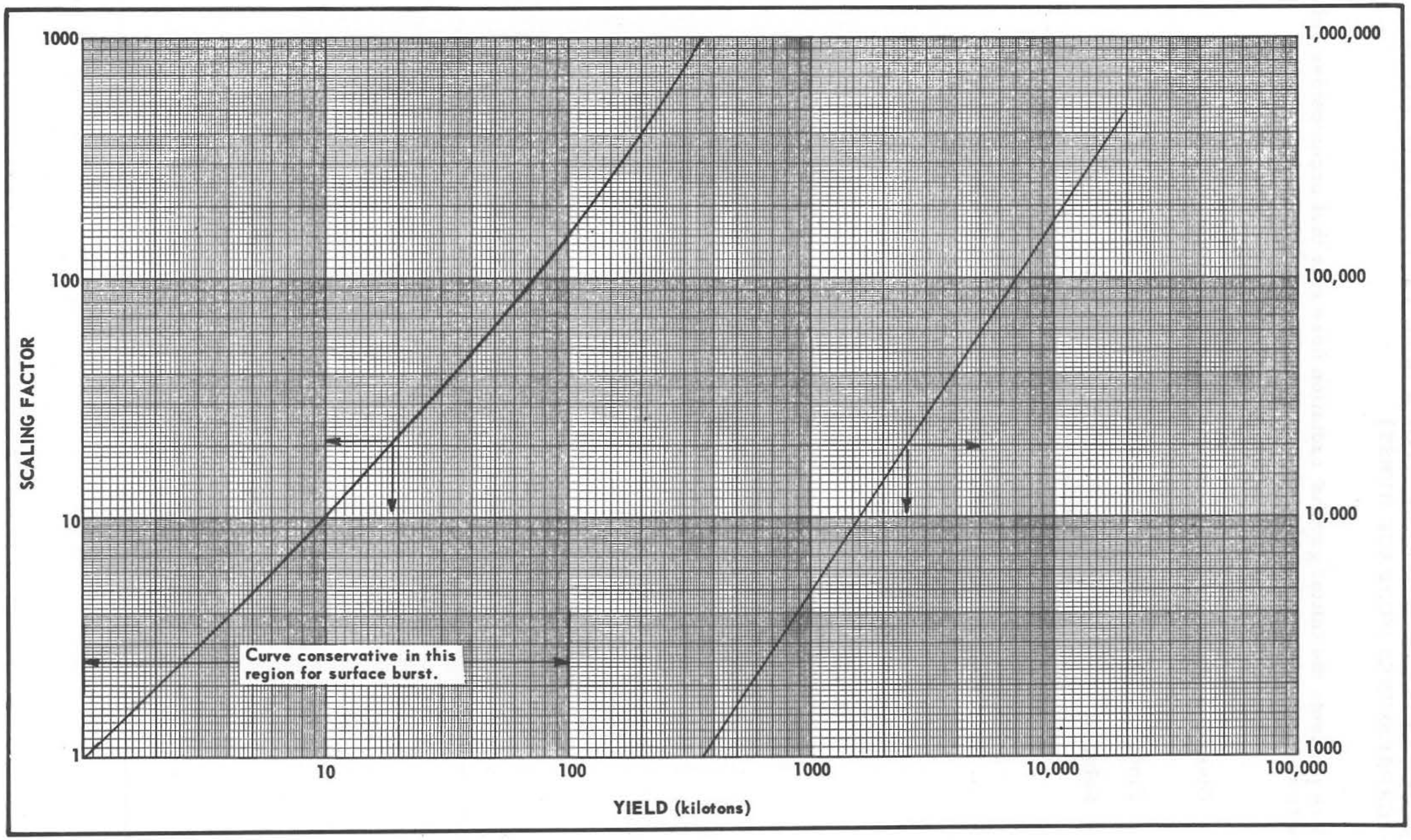


Figure E-7. Scaling Factor for Initial Gamma Radiation Versus Yield

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E8. COMPARABLE EFFECTS OF INITIAL GAMMA DOSE RATES VERSUS YIELD AT VARIOUS PEAK OVERPRESSURES (SURFACE BURST)

Figure E-8 presents the initial gamma radiation dose rate that accompanies selected peak overpressures from the surface burst of a weapon of a given yield.

EXAMPLE

Given: Structure located at such a range as to receive 10 psi from the surface burst of a 100-KT weapon.

Find: Initial gamma radiation dose rate.

Solution: Enter Figure E-8 with a weapon yield of 100 KT and 10 psi; read the value of initial gamma radiation dose rate of 1,250 r.

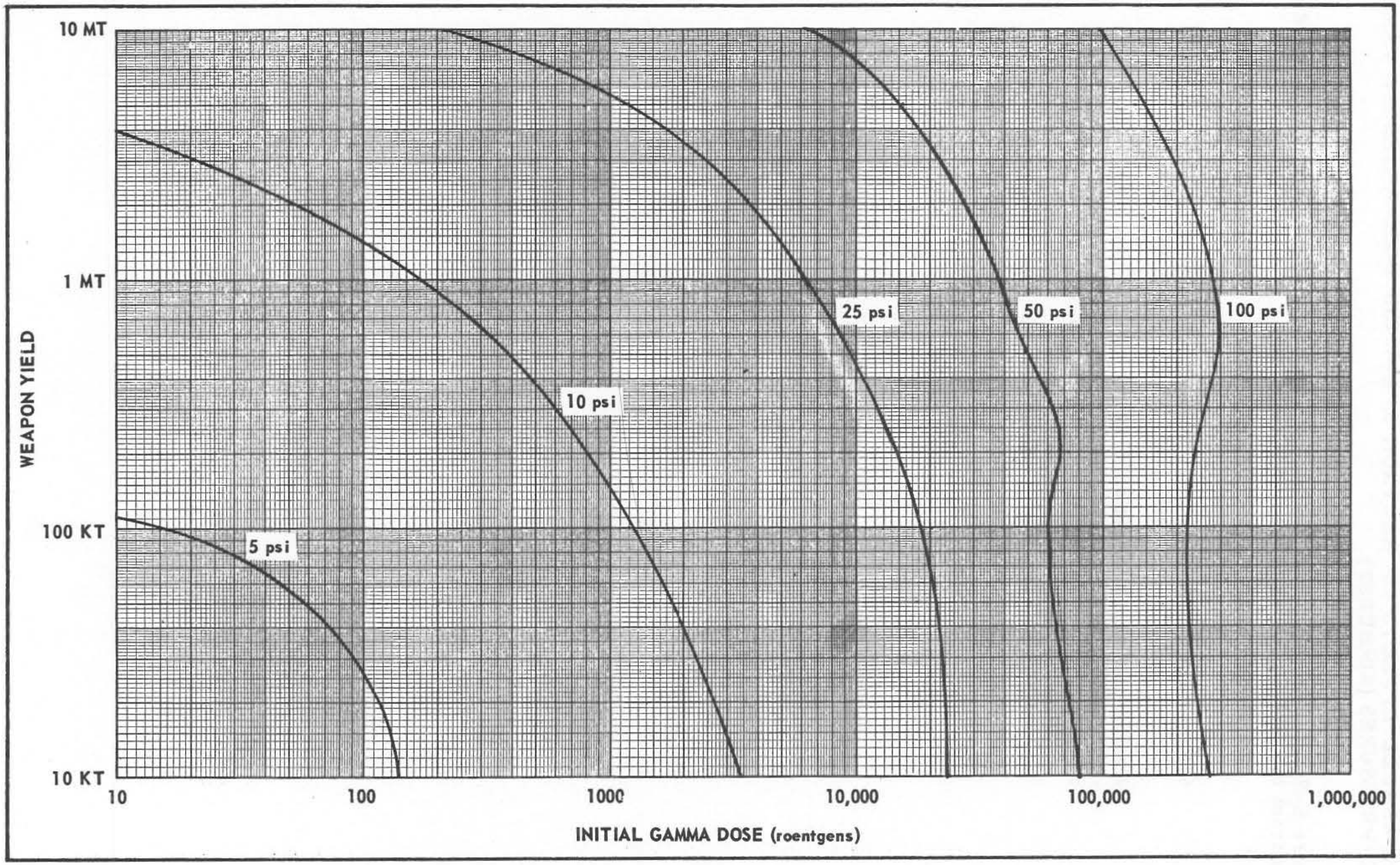

Figure E-8. Comparable Effects of Initial Gamma Dose Rates Versus Yield at Various Peak Overpessures (Surface Burst)

E9. COMPARABLE EFFECTS OF NEUTRON RADIATION DOSE RATES AT VARIOUS PEAK OVERPRESSURES (AIRBURST)

Figure E-9 presents the neutron radiation dose rate that accompanies selected peak overpressures from the airburst of a weapon of a given yield.

EXAMPLE

Given: Structure to be located at such a range as to receive 25 psi from the surface burst of a 1-MT weapon.

Find: Neutron radiation dose rate.

Solution: Enter with a weapon yield of 1-MT and 25 psi; read 26 rem.

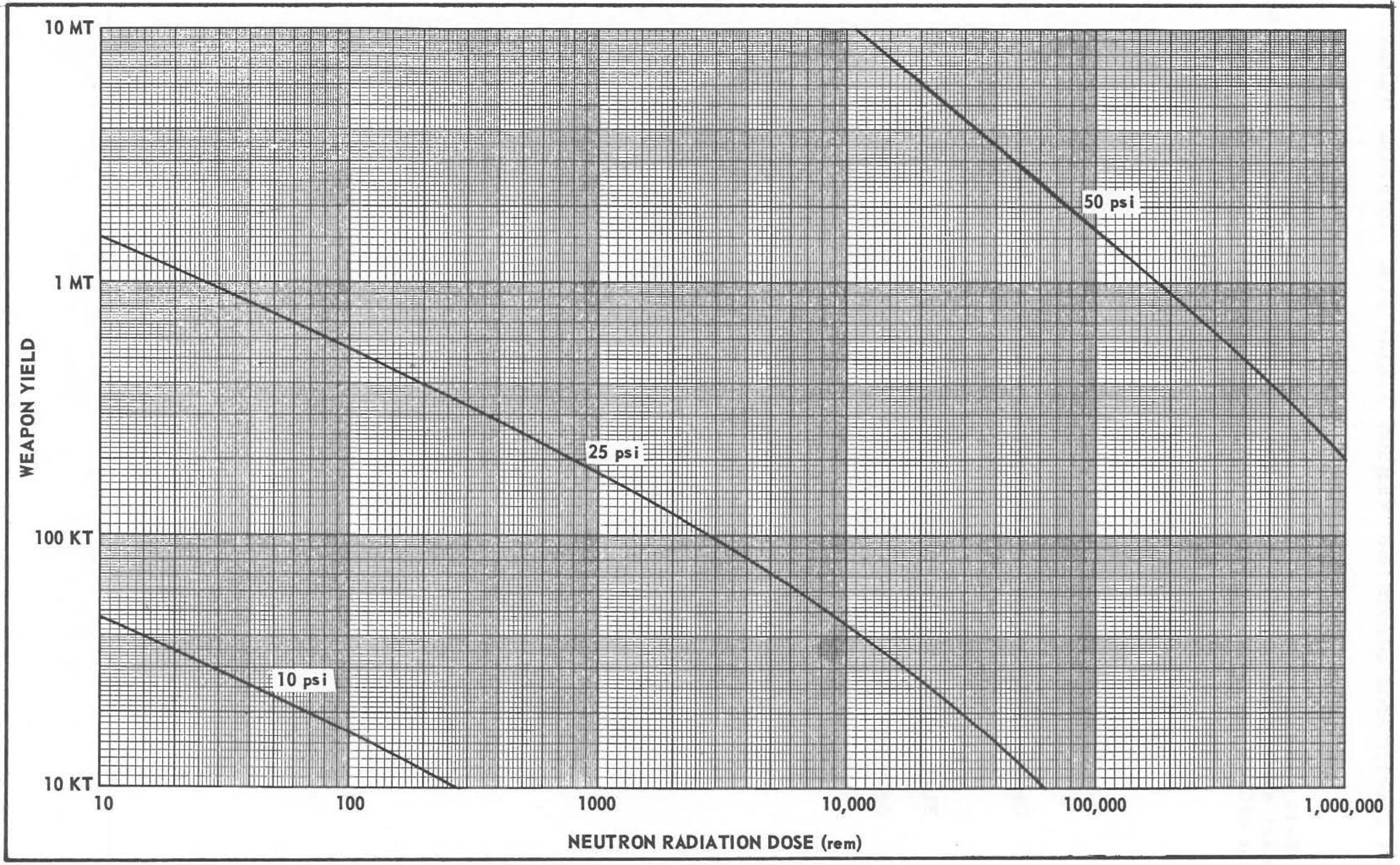

Figure E-9. Comparable Effects of Neutron Radiation Dose Versus Yield at Various Peak Overpressures (Airburst)

E10. CRATER DEPTH AND DIAMETER VERSUS YIELD FOR SURFACE BURSTS IN DRY SOIL

Figure E-10 gives the values of apparent crater diameter and depth as a function of weapon yield for contact surface burst in dry soil. The average values of soil factors to be used as multipliers for estimating crater dimensions in other soil types are as follows.

Soil types	Diameter	Depth
Hard rock (granite or sandstone)	0.8	0.8
Saturated soil	1.7	0.7

EXAMPLE

Given: 20-KT contact surface burst over a sandy loam soil where the water table is within a few feet of the surface.

Find: Crater dimensions.

Solution: From Figure E-10 the crater diameter and depth in dry soil are 340 ft and 54 ft, respectively. By the application of the soil factors that are listed above for saturated soil, the estimated crater dimensions for a 20-KT surface burst over saturated soil will be as follows.

Crater diameter, D_a = 340 x 1.7 = 580 ft
Crater depth, H_a = 54 x 0.7 = 38 ft
Diameter of rupture zone, D_r = 1.5 D_a = 870 ft
Height of lip, H_l = 0.25 H_a = 9 ft

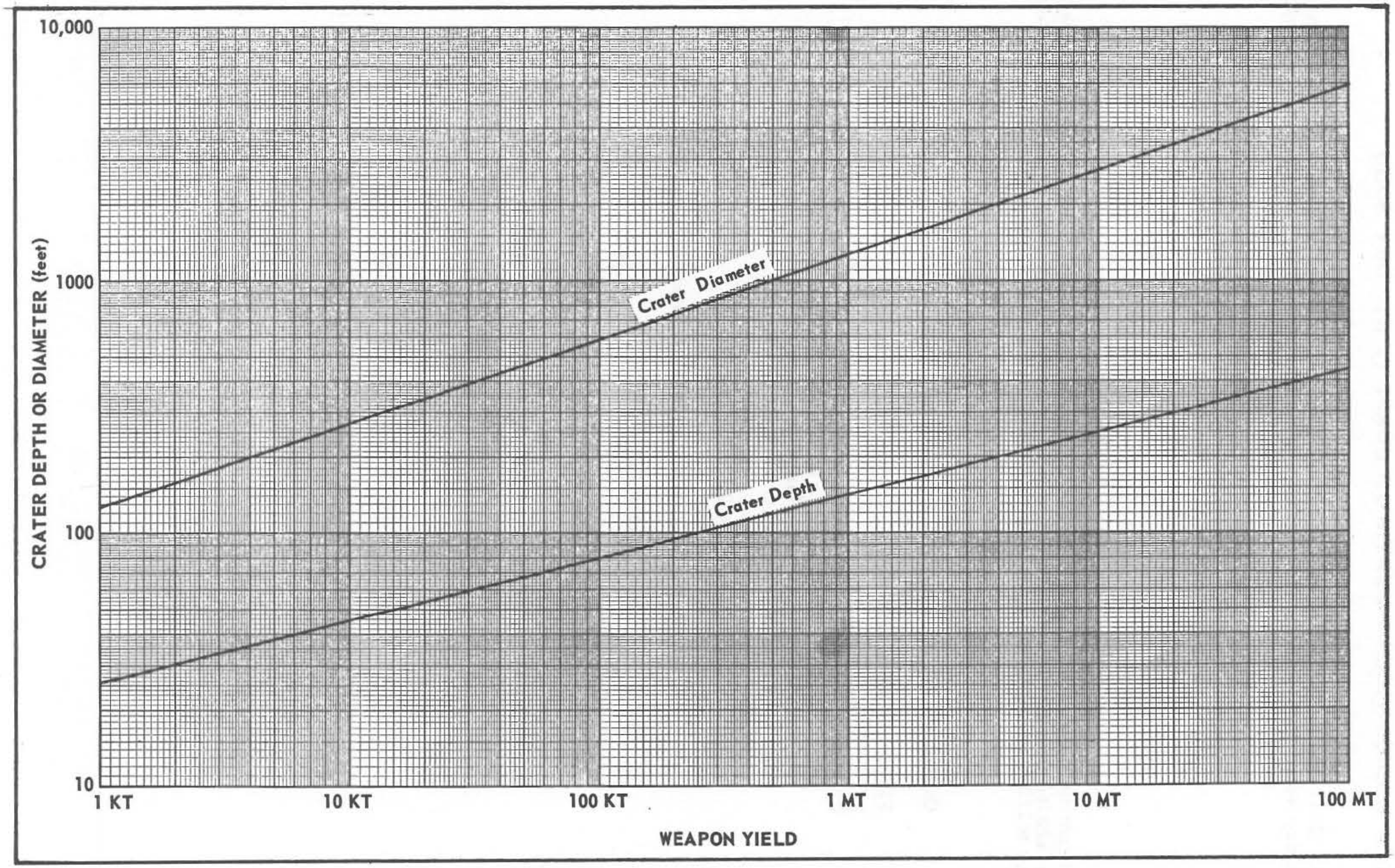

Figure E-10. Crater Depth and Diameter Versus Yield for Surface Bursts in Dry Soil

E11. CRATER RADIUS VERSUS DEPTH OF BURST (1 KT. DRY SOIL)

Figure E-11 gives the estimated crater radius as a function of depth of burst for 1-KT explosion in dry soil. For other soils, multiplication factors should be used as follows.

Soil type	Relative crater radius
Hard rock (granite and sandstone)	0.8
Saturated soil	1.7

SCALING

To determine the crater radius for a W KT yield, the actual burst depth is divided by $W^{1/3}$ to obtain the scaled depth. The radius for 1 KT at this depth, as read from Figure E-11, is then multiplied by $W^{1/3}$.

EXAMPLE

Given: 20-KT burst at a depth of 50 ft in saturated soil.

Find: Crater radius.

Solution: Scaled burst depth is $50/20^{1/3} = 18.5$ ft. From Figure E-11, the crater radius for a 1-KT explosion at this depth is 90 ft. Hence the crater radius for a 20-KT burst at a depth of 50 ft in dry soil is

$$90 \times 20^{1/3} = 244 \text{ ft.}$$

Therefore, the crater radius in saturated soil is

$$244 \times 1.7 = 415 \text{ ft.}$$

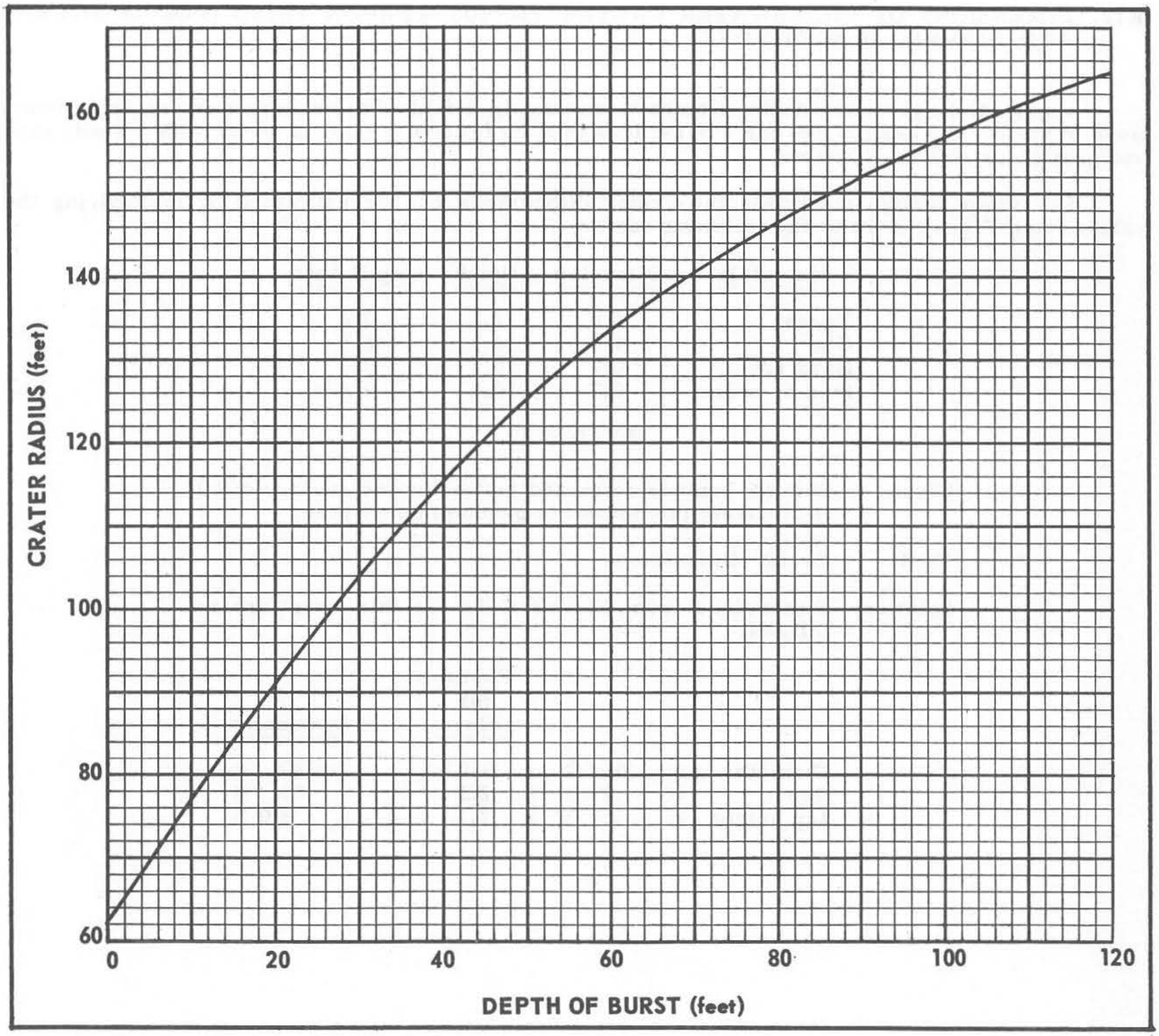

Figure E-11. Crater Radius Versus Depth of Burst (1 KT, Dry Soil)

E12. DIMENSIONS OF UNDERWATER CRATER VERSUS WEAPON YIELD (FOR SAND, SAND AND GRAVEL, OR SOFT ROCK)

Figure E-12 gives the depth, diameter, and the lip height of the underwater crater as functions of yield. The results are for a burst less than 20 ft deep in 60 ft of water with a sand, sand and gravel, or soft rock bottom.

For other bottom materials the crater dimensions can be estimated by multiplying the values from Figure E-12 by the following factors.

Materials	Diameter	Depth	Lip Height
Loess	1.0	1.7	0.7
Clay	1.0	2.3	2.3
Hard rock	0.7	0.5	0.4
Mud or muck	0.7	0.4	0.2

EXAMPLE

Given: 200-KT bomb is detonated just below the surface of 60 ft of water; the bottom is predominantly clay.

Find: Crater dimensions.

Solution: Dimensions from Figure E-12 for this burst are as follows.

				Factor for clay		Dimension
Diameter	=	1,030 ft	x	1.0	=	1,030 ft
Depth	=	37 ft	x	2.3	=	85 ft
Lip height	=	3.5 ft	x	2.3	=	8.0 ft

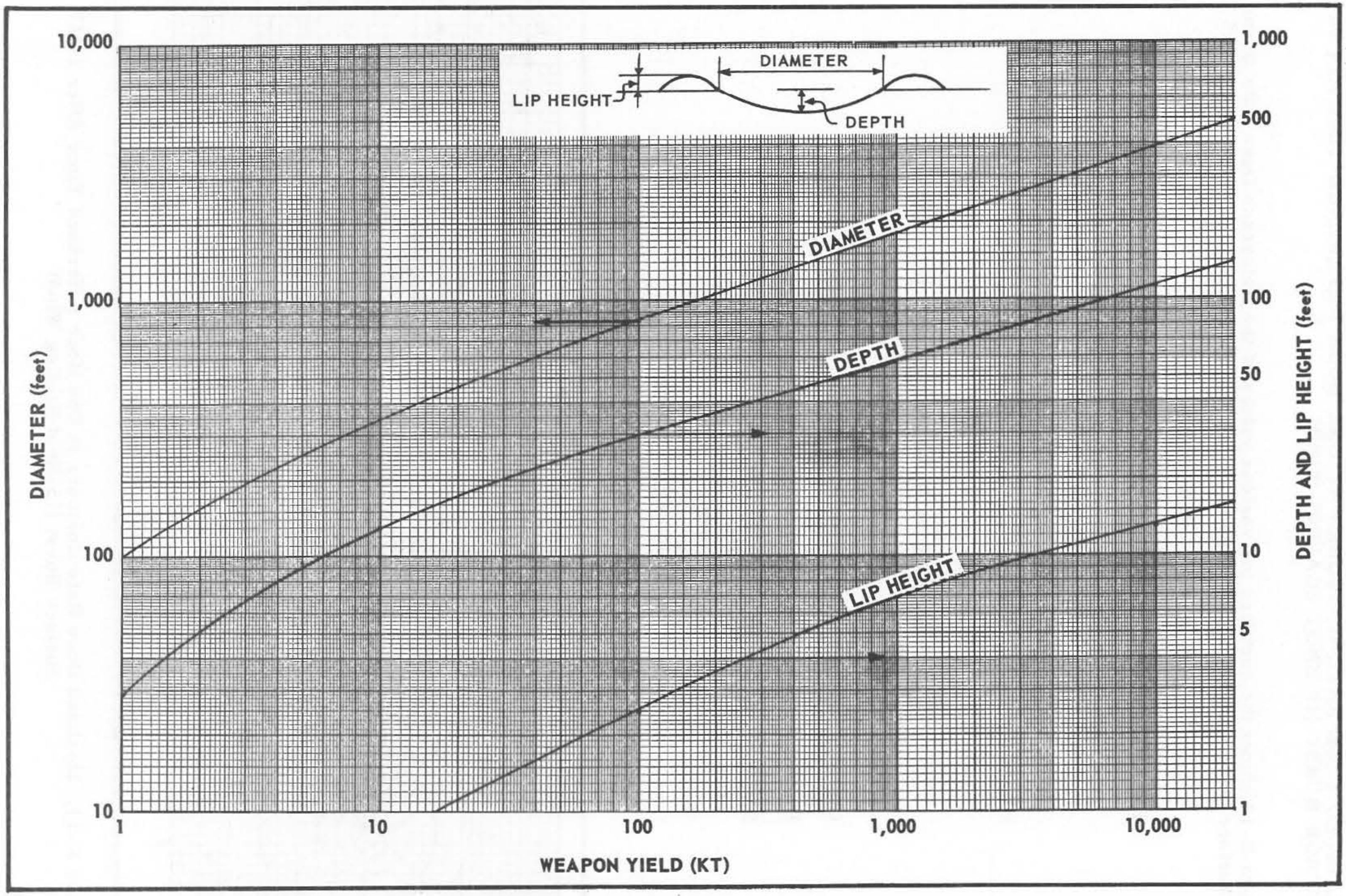

Figure E-12. Dimensions of Underwater Crater Versus Weapon Yield (For Sand, Sand and Gravel, or Soft Rock)

E13. IDEALIZED DOSE RATE CONTOURS AT ONE HOUR REFERENCE TIME AFTER 1-MT SURFACE BURST (15-KNOT SCALING WIND)

Figure E-13 shows the contours for various values of the Reference Dose Rate at one hour after the surface detonation of 1-MT weapon. The scaling wind (from left to right) is 15 knots.

SCALING

For weapon sizes other than 1 MT:

$$I = I_o W^{1/3}$$

$$d = d_o W^{1/3}$$

where

I_o = Dose rate for 1 MT at distance, d_o

I = Dose rate for W MT at distance, d.

EXAMPLE

Given: 10-MT surface burst.

Find: Dose rate at 1 hour at 150 miles downwind.

Solution: $d_o = \dfrac{d}{W^{1/3}} = \dfrac{150}{10^{1/3}} = 70$ mi.

At 70 miles downwind, I_o is 300 r/hr.

Therefore, at 150 miles downwind,

$$I = I_o W^{1/3} = 300 \times 10^{1/3} = 660 \text{ r/hr.}$$

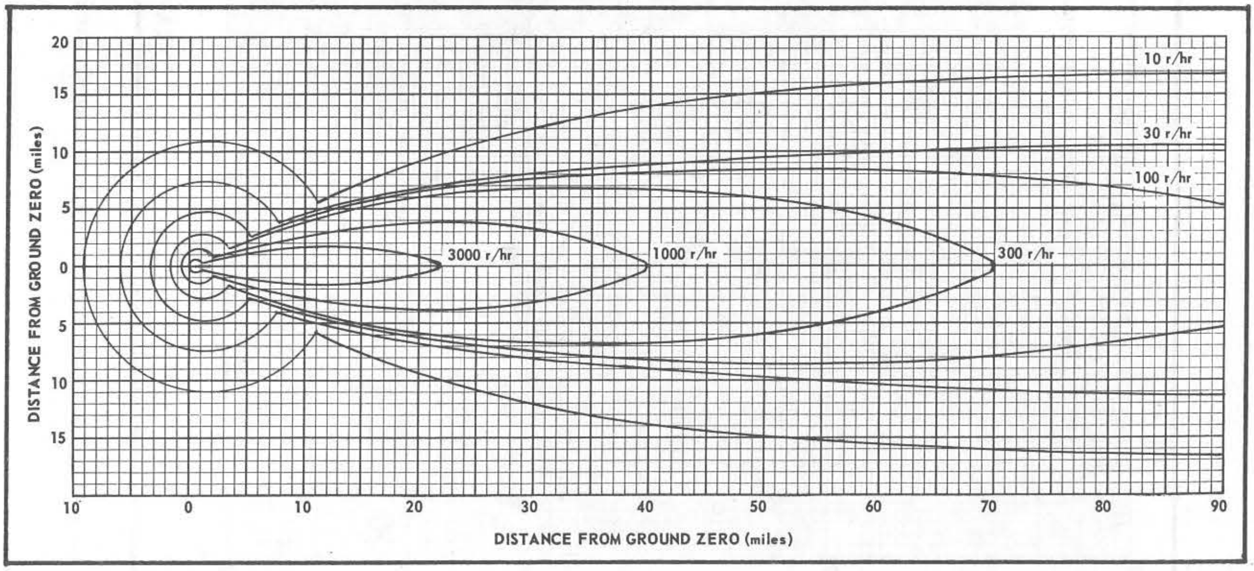

Figure E-13. Idealized Dose Rate Contours at One Hour Reference Time After 1-MT Surface Burst (15-Knot Scaling Wind)

TABLE E-1

Approximate Residual Radiation Dose Rate Contours on Ground at Reference Time of One Hour After 1 Megaton Surface Burst (Scaling Wind of 15 Knots)[1]

Dose rate (r/hr)	Radius of GZ circle (mile)	Displacement of center of GZ circle (mile)	Downwind distance (mile)	Crosswind distance (mile)
3,000	0.43	0.60	22	3.1
1,000	1.40	0.80	40	6.8
300	2.8	1.02	70	11.8
100	4.7	1.24	114	16.7
30	7.5	1.46	183	22.8
10	11.0	1.65	317	34.1

[1] Dose rate contours are for 1-hour reference time. Contours will not be completely established at 1 hour after explosion.

Adjustment Factors for Contour Parameters for Various Scaling Winds

Scaling wind velocity (knot)	Factor
5	0.7
10	0.9
15	1.0
20	1.1
25	1.2
30	1.3
40	1.4
50	1.5

Area = 1 x basic value.
Downwind distance = F x basic value.
Crosswind = (1/F)x basic value.
Diameter of ground zero circle = 1 x basic value.
Downwind displacement of ground zero circle = F x basic value.

TABLE E-2

Density and Velocity of Missiles

Peak overpressure (psi)	Maximum missile density (number per sq ft)	Missile velocity (ft per sec)
5	480	58 - 382
1.7	3.7	35 - 145

E14. DOSE RATE VERSUS TIME AFTER EXPLOSION

Figure E-14 gives the ratio of the dose rate in r/hr at any time after the explosion to the dose rate in r/hr at one hour after the explosion as a function of the time after the explosion in hours.

EXAMPLE

At 30 minutes after an atomic explosion the radiation dose rate at a certain place, because of fallout, was found to be 20 roentgens per hour (20 r/hr). What would the dose rate be after 24 hours?

Solution: Enter time scale within 30 minutes, intersect curve to obtain value of 2.35 for ratio of dose rate at 30 minutes to dose rate at 1 hour.

Therefore,

$$\frac{20}{\text{Dose rate @ 1 hr}} = 2.35.$$

Then,

$$\text{Dose rate @ 1 hr} = \frac{20}{2.35} = 8.5 \text{ r/hr}.$$

Enter time scale with 24 hours, intersect curve to obtain time value of .022 for ratio of dose at 24 hours to dose rate at 1 hour.

Therefore,

$$\frac{\text{Dose rate @ 24 hr}}{\text{Dose rate @ 1 hr}} = 0.022.$$

Then,

$$\text{Dose rate @ 24 hr} = .022 \times 8.5 = 0.187 \text{ r/hr}.$$

Directly: $\text{Dose rate at X hours} = \text{Dose rate at Y hours} \times \frac{(\text{Ratio for X hr})}{(\text{Ratio for Y hr})}.$

Therefore,

$$\text{Dose rate @ 24 hr} = \frac{20}{2.35} \times 0.022 = 0.187 \text{ r/hr}.$$

Note: The Abscissa scale may be used in days if the ratio values in hours are multiplied by .022. For example, to find the ratio for days, the ratio for 2 hr = .45. Therefore, the ratio for 2 days = .45 x .022 = .01.

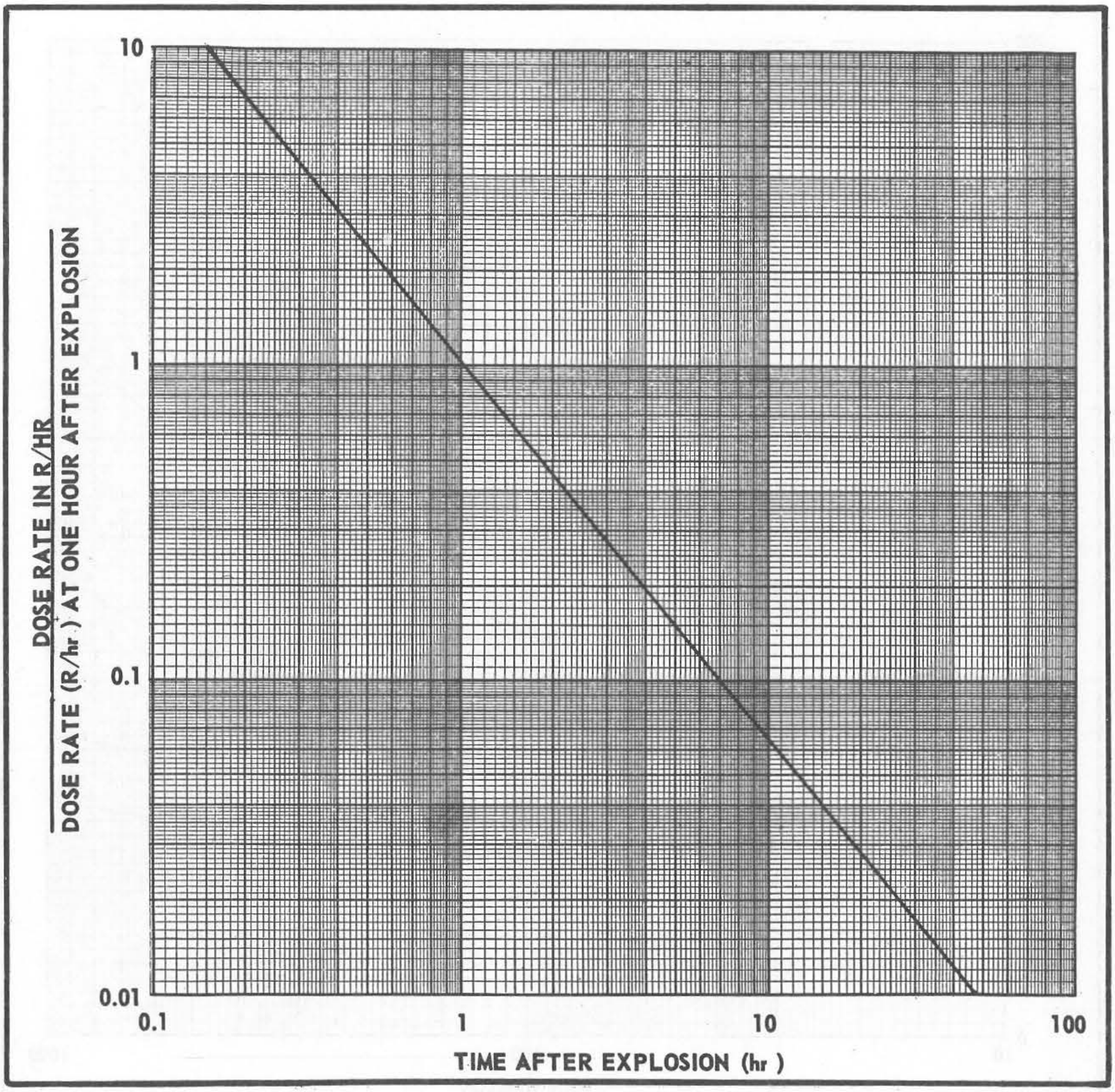

Figure E-14. Dose Rate Versus Time After Explosion

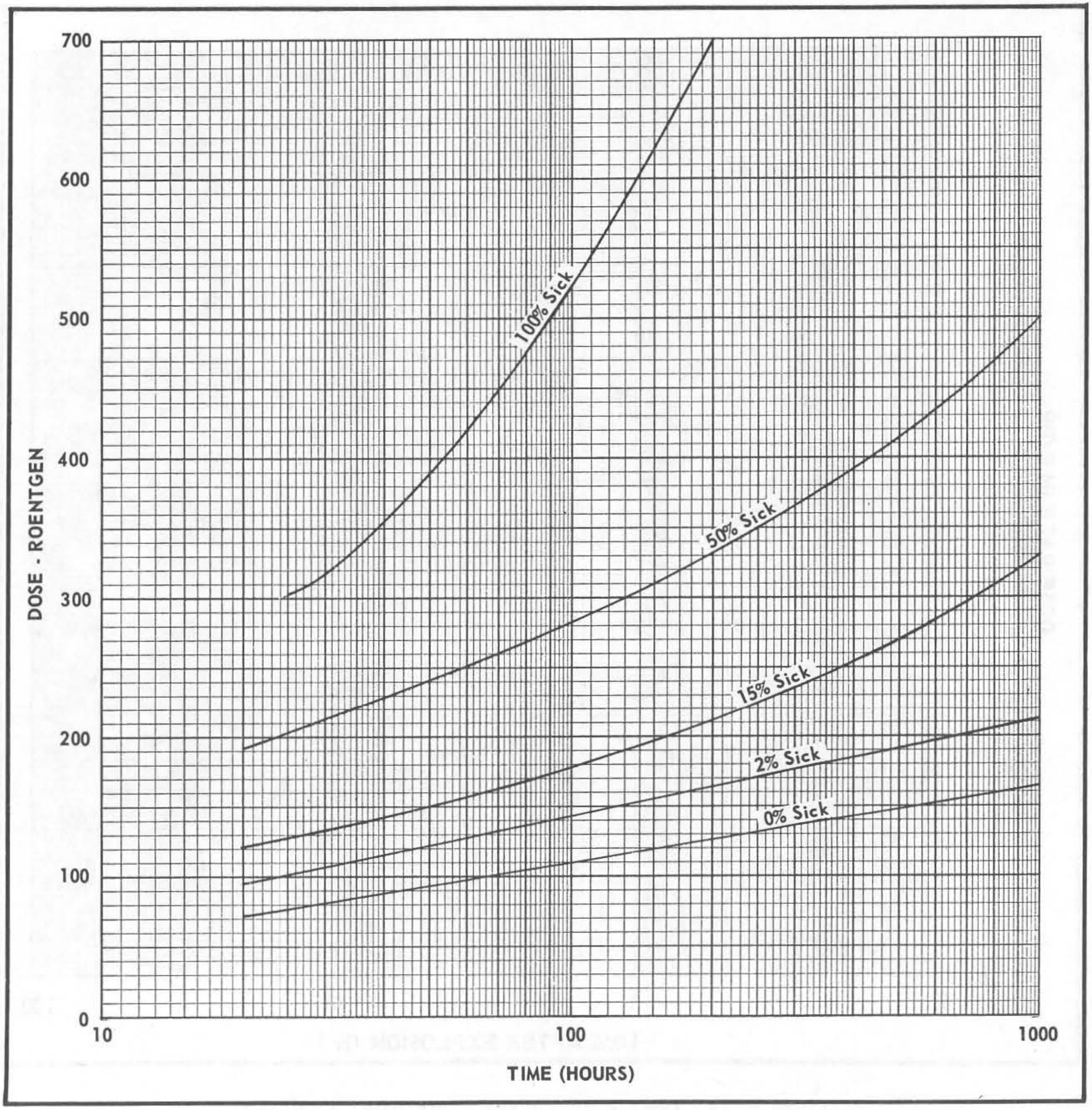

Figure E-15. Estimated Percent Casualties From Nuclear Radiation as a Function of Total Dose and Time Over Which Dose is Delivered

TABLE E-3

Potential Antipersonnel Biological Agents

Disease	Organism	Communication	Incubation period	Distribution
Anthrax	Bacillus	Contact Inhalation of spores Mechanical vectors Ingestion	1 to 7 days	Rare in man
Bacillary dysentery	Bacillus	Contact Ingestion Mechanical vectors	1 to 7 days	Endemic throughout world
Cholera	Bacillus	Contact Ingestion Mechanical vectors	1 to 5 days	Endemic in Orient
Coccidioido-mycosis	Fungus	Inhalation of spores Perhaps contact	1 to 2 weeks	Southwest U. S. A., Mexico, Argentina, Uruguay
Encephalitis (Several types)	Viruses	Mosquito vectors Tick vectors (One type)	2 to 15 days	Specific types in various parts of world
Glanders	Bacillus	Inhalation Contact Ingestion	3 to 5 days	Largely Asia and India
Histoplas-mosis	Fungus	Not known	Not known	Probably general
Infectious hepatitis	Viruses A and B	A: not known B: transfusions	A: 15 to 40 days B: 40 to 150 days	General
Influenza	Viruses A and B	Contact	A: 1 to 2 days B: 12 to 18 hours	General
Plague (bubonic)	Bacillus	Flea vectors	4 to 7 days	Endemic in Asia
Plague (pneumonic)	Bacillus	Contact	1 to 7 days	Endemic in Asia
R. M. Spotted fever	Rickettsiae	Tick vectors	3 to 10 days	North and South America
Scrub typhus	Rickettsiae	Mite vectors	7 to 10 days	Orient
Staphylococcus poisoning	Toxins of staphylo-cocci	Ingestion	Up to 4 hours	General
Tularemia	Bacillus	Contact Ingestion Vectors	1 to 10 days	North America, Europe, Japan
Typhus	Rickettsiae	Vectors Contact	6 to 15 days	General
Q-fever	Rickettsiae	Not definitely known	14 to 26 days	Apparently widespread

TABLE E-4

Estimated Blast Damage from Nuclear Weapons

[1 Kiloton = 1,000 tons; 1 Megaton = 1,000,000 tons; 1 (X)-Atomic bomb of size used during World War II]

Bomb size (TNT equivalent)	Zone of A damage		Zone of B damage		Zone of C damage		Zone of D damage	
	Radius (in miles)	Area (in square miles)	Radius (in miles)	Area (in square miles)	Radius (in miles)	Area (in square miles)	Radius (in miles)	Area (in square miles)
Kilotons:								
20 .... 1(X). .	0.0-0.5	0.8	0.5-1.0	2.3	1.0-1.5	3.9	1.5-2.0	5.5
40 .... 2(X). .	0.0-0.6	1.3	0.6-1.3	3.8	1.3-2.0	6.2	2.0-2.5	8.7
50 .... 2-1/2(X). .	0.0-0.7	1.5	0.7-1.4	4.2	1.4-2.0	7.1	2.0-2.7	10.1
60 .... 3(X). .	0.0-0.7	1.6	0.7-1.4	4.9	1.4-2.2	8.1	2.2-2.9	11.4
80 .... 4(X). .	0.0-0.8	2.0	0.8-1.6	6.0	1.6-2.4	10.0	2.4-3.2	14.0
100 .... 5(X). .	0.0-0.9	2.3	0.9-1.7	6.9	1.7-2.6	11.5	2.6-3.4	16.1
120 .... 6(X). .	0.0-0.9	2.6	0.9-1.8	7.8	1.8-2.7	13.0	2.7-3.6	18.2
140 .... 7(X). .	0.0-1.0	2.9	1.0-1.9	8.6	1.9-2.9	14.4	2.9-3.8	19.4
160 .... 8(X). .	0.0-1.0	3.1	1.0-2.0	9.4	2.0-3.0	15.7	3.0-4.0	22.0
Megatons:								
1 .... 50(X). .	0.0-1.8	11	1.8-3.7	32	3.7-5.5	53	5.5-7.4	74
2 .... 100(X). .	0.0-2.3	17	2.3-4.6	51	4.6-7.0	84	7.0-9.3	118
5 .... 250(X). .	0.0-3.2	31	3.2-6.3	94	6.3-9.5	156	9.5-12.6	218
10 .... 500(X). .	0.0-4.0	50	4.0-7.9	149	7.9-11.9	248	11.9-15.9	346
20 .... 1,000(X). .	0.0-5.0	80	5.0-10.0	230	10.0-15.0	390	15.0-20.0	550

TABLE E-5

Shatter Pressure for Window Glazing Materials

Glazing material	Approximate critical shatter pressures in psi for 14" x 20" panes
Single strength window glass - 0.087"	0.30
Double strength window glass - 0.118"	0.55
3/16" Window glass	1.40
1/4" Plate glass	2.50
1/4" Safety sheet glass	2.50
1/4" Wired glass--figured	2.50
1/4" Polished wired glass	2.50
1/4" Tempered glass	12.00
1/4" Double plate with 1/4" space	3.50
1/10" Plastic acrylic	2.40
1/8" Plastic acrylic	3.70
3/16" Plastic acrylic	8.30
1/4" Plastic acrylic	14.80

Note: For other pane sizes, the shatter pressure (P) is:

$$P = \frac{KRt^2}{A} \text{ (in psi)}$$

where

K = a constant = Approximately (62,000 for acrylic plastic (50,000 for tempered glass (10,500 for ordinary window glass

t = thickness in in.
A = area in sq in.
R = size of pane factor from the following tabulation.

Ratio of short to long side	R
1.0	1.000
0.9	1.005
0.8	1.02
0.7	1.07
0.6	1.14
0.5	1.25
0.4	1.45
0.3	1.8
0.2	2.6
0.1	5.0

EXAMPLE

Find the shatter pressure for an 18" x 36" pane of double strength window glass.

$$P = \frac{KRt^2}{A} = \frac{10{,}500 \times 1.25 \times (.118)^2}{18 \times 36} = 0.28 \text{ psi.}$$

E15. DAMAGE CLASSIFICATION

The general degrees of damage that are applicable to structures and equipment are classified as follows.

A. The structure is virtually completely destroyed.

B. The damage is so severe that complete reconstruction is required prior to its re-use.

C. The structural damage is such that major repairs are required before the structure can be used for its intended purpose.

D. The structure received light damage, so that only minor makeshift repairs (or no repairs at all) are required to maintain its usefulness.

The degrees of damage that are applicable to specific types of targets are shown in Table E-6, Table E-7, Table E-8, and Table E-9.

TABLE E-6

Damage Criteria for Shallow-Buried or Earth-Covered Structures

Type of structure	Damage class	Peak over-pressure (psi)	Nature of damage
Light corrugated steel arch surface structure (10-gage, span 20-25 ft) with earth cover over crown	A	35-40	Complete collapse
	B	30-35	Collapse of portion of arch facing the blast
	C	20-25	Deformation of end walls and arch, possible door damage
	D	10-15	Possible damage to ventilation system and door
Light R/C surface or underground shelter with 3-ft earth cover (2- to 3-in. thick panels, beams spaced at 4-ft centers)	A	30-35	Collapse
	B	25-30	Collapse of portion of arch
	C	15-25	Deformation, severe cracking and spalling of panels
	D	10-15	Cracking of panels, possible door damage

E16. DAMAGE-DISTANCE RELATIONSHIP AS A FUNCTION OF EXPLOSION ENERGY YIELD FOR DIFFRACTION-TYPE STRUCTURES

The nomogram and bar chart in Figure E-16 give the nature of the damage that may be expected to be sustained by representative diffraction-type structures at various distances from ground zero for various weapon yields. The symbols A, B, C, and D for various degrees of damage are defined for the structures that are listed in paragraph E15.

SCALING

The chart may be used directly for yields from 1 KT to 20,000 KT (20 MT). For yields in excess of 20 MT, the scaling law is

$$d = \frac{W^{1/3}\, d_o}{2.71}$$

where

d = distance from ground zero for W MT explosion to cause a specific damage,

d_o = distance from ground zero for 20-MT explosion to cause the same damage, and

W = weapon yield in MT.

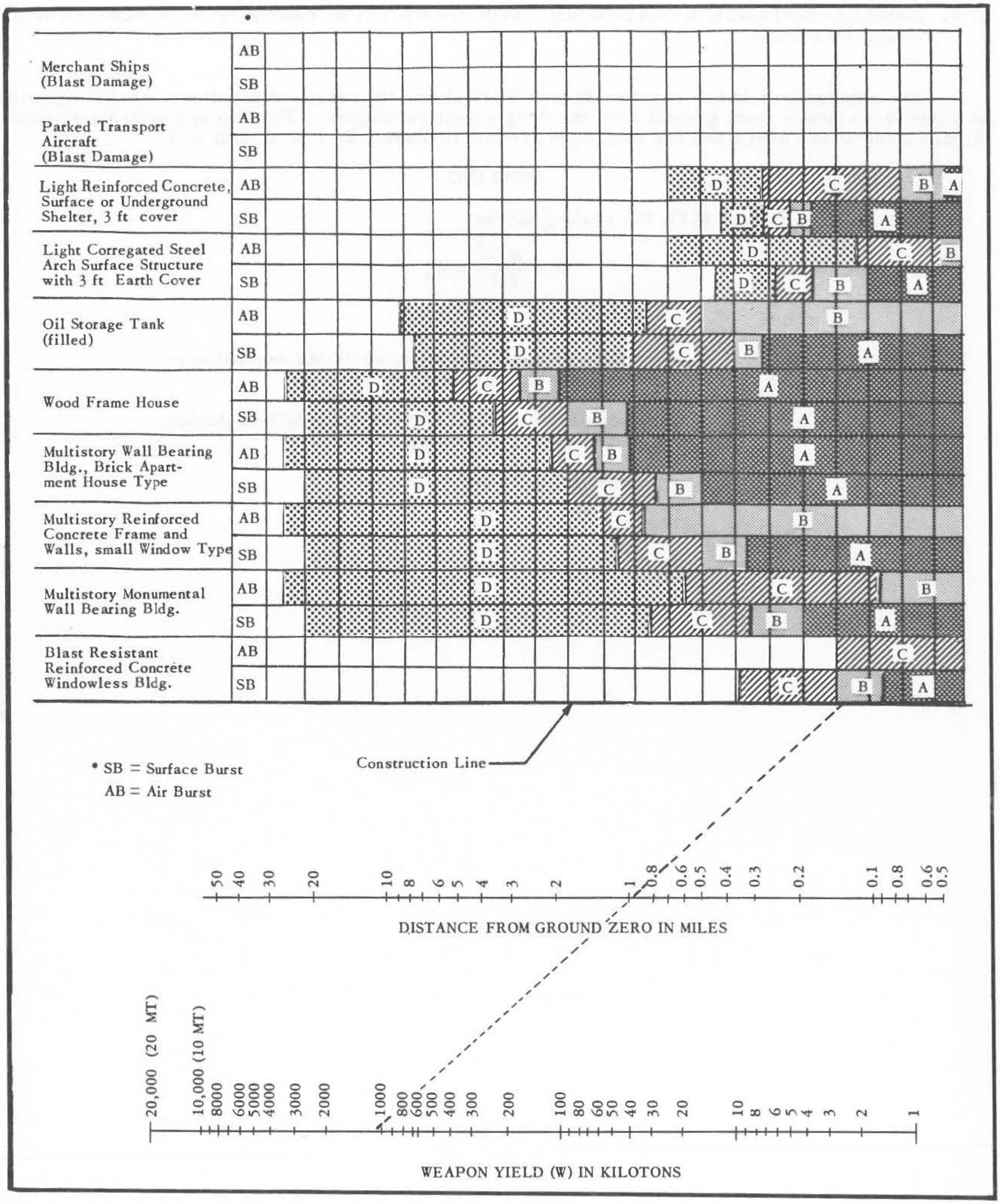

Figure E-16. Damage-Distance Relationship as a Function of Explosion Energy Yield for Diffraction-Type Structures

E17. DAMAGE-DISTANCE RELATIONSHIP FOR DRAG-TYPE TARGETS AS A FUNCTION OF WEAPON YIELD

The nomogram and bar chart in Figure E-17 shows the nature of the damage to be expected at various distances from ground zero for drag sensitive targets. The damage criteria symbols A, B, C, and D are described for drag-type targets in Tables E-7, E-8, and E-9.

SCALING

Above 20,000 KT (20 MT), the scaling law is

$$d = \frac{W^{1/3}}{2.71} = d_o$$

where

d = distance from ground zero for W MT explosion to cause a specific damage,

d_o = distance from ground zero for a 20-MT explosion to cause the same damage, and

W = weapon yield, in MT.

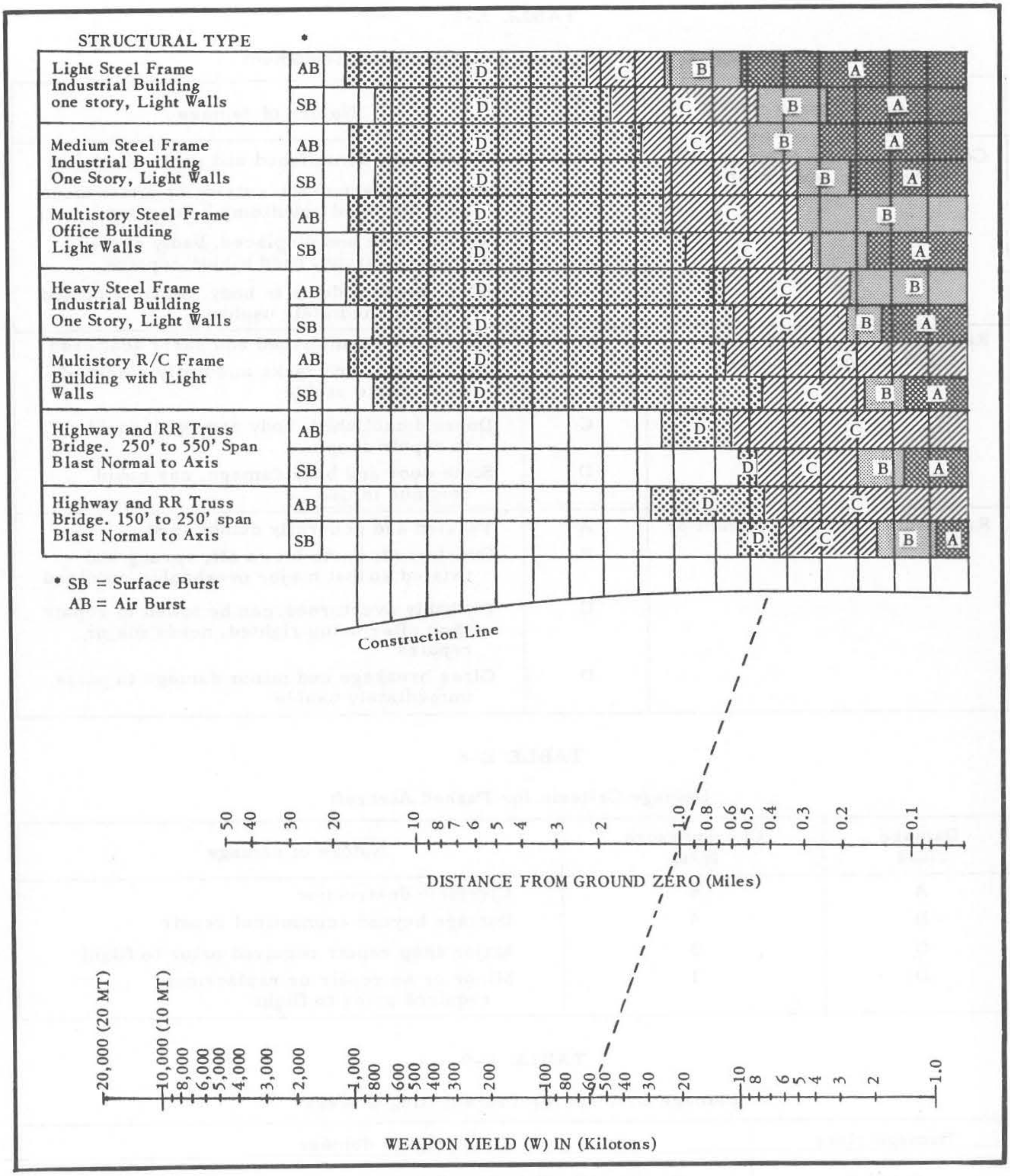

Figure E-17. Damage-Distance Relationship for Drag-Type Targets as a Function of Weapon Yield

TABLE E-7

Damage Criteria for Land Transportation Equipment

Type of equipment	Damage class	Nature of damage
Commercial-type vehicles and construction equipment	A	Completely demolished and parts scattered
	B	Large displacements, outside appurtenances torn off, need rebuilding before use
	C	Turned over and displaced, badly dented, frames sprung, need major repairs
	D	Glass broken, dents in body, possibly turned over, immediately usable
Railroad rolling stock (box, tank, and gondola cars)	A	Completely demolished and parts scattered
	B	Car blown from tracks and badly smashed, some parts usable
	C	Doors demolished, body damaged, could roll to repair shop
	D	Some door and body damage, car could continue in use
Railroad locomotives (diesel or steam)	A	Twisted and generally demolished
	B	Overturned, parts blown off, sprung and twisted so that major overhaul is required
	C	Probably overturned, can be towed to repair shop after being righted, needs major repairs
	D	Glass breakage and minor damage to parts, immediately usable

TABLE E-8

Damage Criteria for Parked Aircraft

Damage class	Overpressure (psi)	Nature of damage
A	6	Complete destruction
B	4	Damage beyond economical repair
C	3	Major shop repair required prior to flight
D	1	Minor or no repair or replacement required prior to flight

TABLE E-9

Damage Criteria for Transmitting Towers

Damage class	Nature of damage
A and B	Towers demolished or flat on ground
C	Towers partially buckled, but held by guylines; ineffective for transmission
D	Guylines somewhat slack but tower usable for transmission

TABLE E-10

Reduction of Interior Thermal Radiation by Window Covering

Material	Reduction (%)
Window glass	0
Aluminum shade screen and glass	70
Aluminum venetian blind (slats closed)	98
Aluminum venetian blind (slats at 45°)	30
Aluminum insect screen 24 x 24 and 20 x 20 mesh to the inch	50
Aluminum insect screen 14 x 18 mesh to the inch	35
Glass coating--Bon Ami	50
Whiting	90
Opaque paint	35

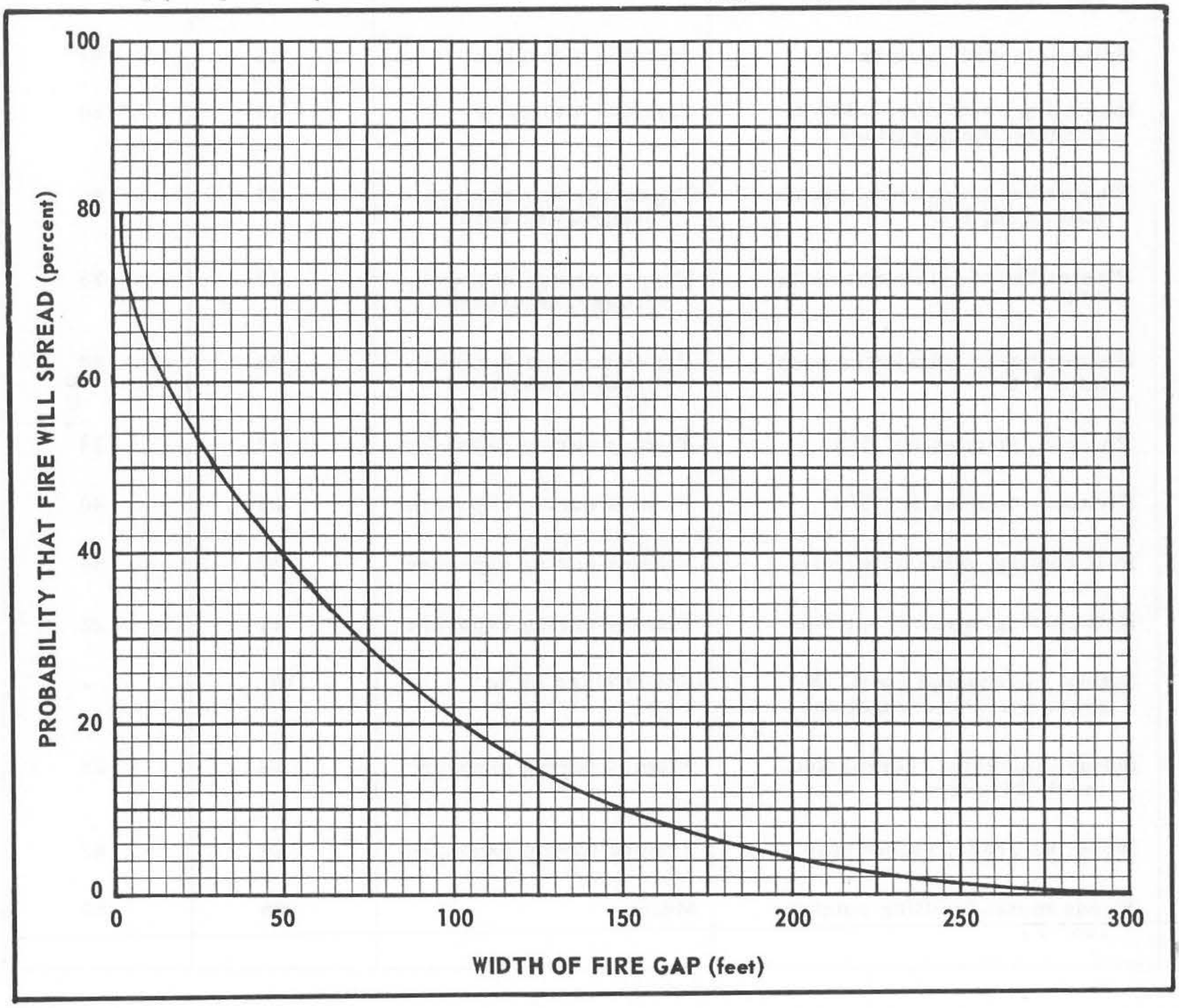

Figure E-18. Probability of Firespread Versus Width of Fire Gap

TABLE E-11 (1 of 3)

Critical Thermal Energies for Materials[1]

Material	Effect	Critical energy (cal/sq cm)	
		KT weapons	MT weapons
CONSTRUCTION MATERIALS			
Acoustical tile, fibretone, 1/2" thick	Sustains afterglow	47	94
Acoustical tile, acousticelotex, cane fiber tile, 1/2" thick	Sustains afterglow	46	92
Building board, celotex	Sustains afterglow	46	92
Insulating sheathing, celotex, 1" thick, black surface	Sustains afterglow	40	80
Plaster board, gypsum, plain wallboard, 1/2"	Paper surface charred through, destroyed	43	86
Plaster board, plain rock lath, 3/8"	Paper surface charred through, destroyed	39	78
Plaster board, insulating rock lath, 3/8"	Paper surface charred through, destroyed	44	88
Plywood, douglas fir, 1/4"	Flames during exposure	17	34
Plywood, douglas fir, 3/8"	Flames during exposure	20	40
Roll roofing, mineral surface	Flames during exposure	27	54
Roll roofing, smooth surface	Flames during exposure	11	22
Siding, corrugated steel, 28-gage, 1-1/4" corrugations	Not affected up to	107	-
Siding, galbestos, corrugated sheet, 22-gage	Flames during exposure	14	28
Wood, #2 grade, yellow pine	Flames during exposure	21	42
Woods metal (melting point 165° F)	Melts	25	50

[1]The values in this table are approximations. Values for actual samples under given conditions vary, depending on size, thickness, backing, color, moisture content, and orientation.

TABLE E-11 (2 of 3)

Critical Thermal Energies for Materials

Material	Effect	Critical energy (cal/sq cm)	
		KT weapons	MT weapons
ELECTRICAL CABLE			
Bell wire, insulated, annunciator, wire, twisted pair, #20	Flames during exposure	13	26
BX, armored, 14-2, 600-volt	Not affected up to	107	-
Cord, rubber insulated, #12-2, 600-volt	Flames during exposure	13	26
Romax, nonmetallic sheathed, 14-2, 600-volt	Charring	8	16
FABRICS			
Acetylated cotton coated with white plasticol (canopy material)	Destroyed	61	-
Awning, canvas (green)	Ignites	6	9
Denim, cotton (blue)	Ignites	9	15
Drapery, rayon acetate (wine)	Ignites	9	16
Flannel, wool (black)	Ignites	12	28
Shantung, acetate (black)	Ignites	9	20
Sheeting, cotton, (unbleached)	Ignites	8	13
Twill, rayon (beige)	Ignites	8	16
Twill, rayon (black)	Ignites	7	14
Venetian blind tape, cotton (white)	Ignites	10	17
Window shade, oiled (green)	Ignites	5	11
EXTERIOR PRIMARY IGNITION POINT AND TRASH-TYPE MATERIALS			
Excelsior	Ignites	9	12
Grass, coarse	Ignites	7	16
Leaves	Ignites	6	12
Paper, crumpled newspaper	Ignites	4	11
Paper, shredded newsprint	Ignites	3	8
Paper, trash can with papers	Ignites	6	12
Paper, fiberboard carton with papers	Ignites	8	12
Rags	Ignites	4	8
Waste, oily	Ignites	5	5
Wood, punky	Ignites	4	9

TABLE E-11 (3 of 3)

Critical Thermal Energies for Materials

Material	Effect	Critical energy (cal/sq cm)	
		KT weapons	MT weapons
MISCELLANEOUS MATERIALS			
Bristol board, 3-ply (dark)	Ignites	8	13
Bristol board, 3-ply (white)	Ignites	12	17
Dust mop, cotton (grey)	Ignites	3	5
Hose, fire, cotton, rubber-lined, 2-1/2"	Flames during exposure	20	-
Paint, fire-resistant (white), 1 coat on 1/4" plywood	Flames during exposure	21	-
Paint, fire-resistant (white), 1 coat on 1/32" steel plate	Charring	58	-
Strawbroom (yellow)	Ignites	8	17
Tampico fiber brush (grey)	Ignites	9	27

E18. TOTAL RADIATION DOSE-RATE FROM FALLOUT IN A CONTAMINATED AREA

Figure E-19 gives curves for determining the total radiation dose from fallout in a contaminated area as a function of the time of entry into the contaminated area after the explosion (or time of arrival of the contamination after the explosion) and the time spent in the contaminated area.

Example: Find the total radiation dose from fallout that is received by an individual who enters a region 2 hours after the explosion and remains for 8 hours if the dose rate 1 hour after the explosion is 20 r/hr.

Solution: By entering with a value of 2 hours for the time after explosion and intersecting the curve for 8 hours in the contaminated area, a multiplying factor of 1.2 is obtained. Therefore, the total accumulated dose is

20 x 1.2 = 24 roentgens.

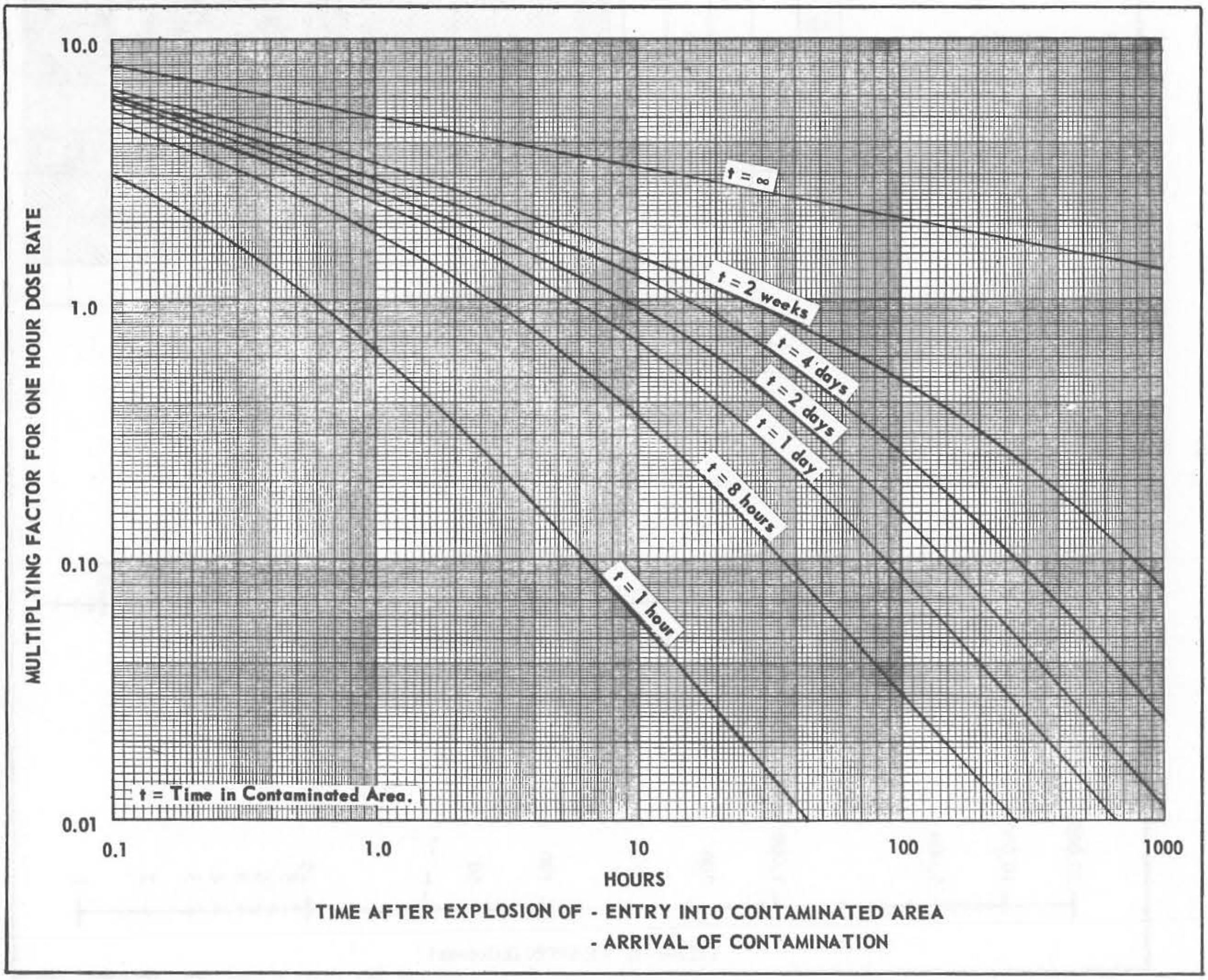

Figure E-19. Total Radiation Dose-Rate from Fallout in a Contaminated Area

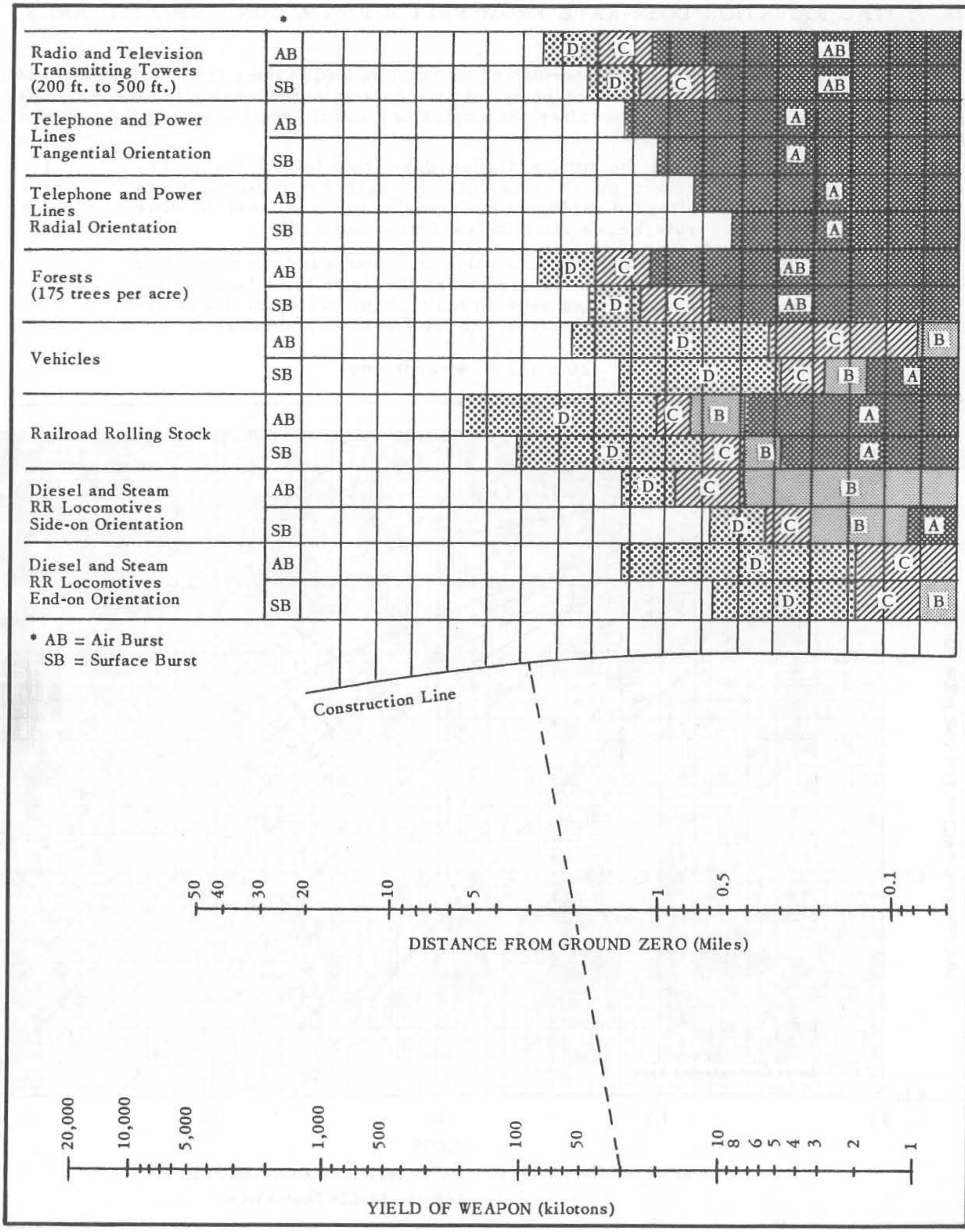

Figure E-20. Damage-Distance Relationships for Drag-Type Targets as a Function of Weapon Yield

(For scaling formula, see paragraph 17)

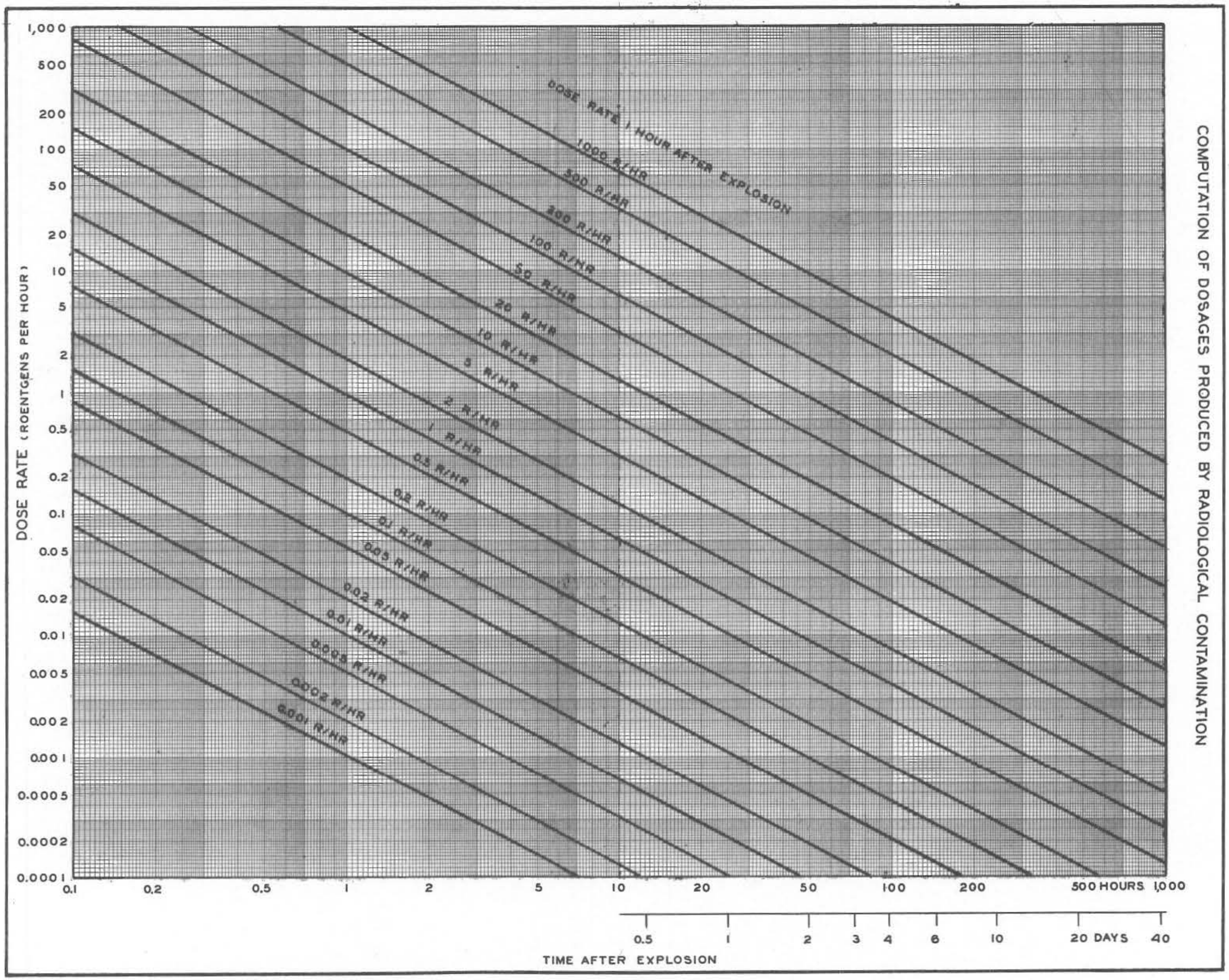

Figure E-21. Chart for Estimation of Dose Rates at Various Times After an Atomic Explosion

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APPENDIX F

MONITORING WITH FISH FOR CW AGENTS IN WATER

APPENDIX F

MONITORING WITH FISH FOR CW AGENTS IN WATER

F1. INTRODUCTION

With the development of more toxic CW agents, it becomes increasingly important to explore all possible methods for the detection, identification, and measurement of contaminants in water supplies.

Chemical methods have been developed for the detection and measurement of certain CW agents in water. However, the use of such methods to continuously monitor water supplies would be somewhat difficult and costly. Also, other contaminants may be used for which chemical methods have not been developed. Because fish are extremely sensitive to certain toxicants, they provide a rapid and inexpensive means of continuous detection.

After the initial detection of contaminants by fish, other methods may be used to further estimate the type and quantity of any contaminant. Fish, though not truly selective, do have certain physiological reactions and time of effect-concentration relationships that may be useful in identifying and estimating concentrations of a contaminant.

F2. TEST FISH

The fish that are used for monitoring must be able to live in the normal water supply, tolerate handling, be small and uniform, and react quickly to concentrations of the contaminant that would be harmful to man.

Tests were made with five species of fish to determine their suitability for monitoring purposes. Of these the fathead minnow (Pimephales promelas), ranging in length from 50 mm to 65 mm and weighing about 1 to 1.5 grams, was used in most of the tests. Bluegills (Lepomis macrochirus), green sunfish (Lepomis cyanellus), and goldfigh (Carrassius auratus) of similar size and weight were also used, as were guppies (Lebistes reticulatus) that weighed approximately 0.1 gram and ranged from 20 mm to 32 mm in length. All of these species proved suitable for use in monitoring systems.

F3. CONDITIONS

Generally, the dissolved oxygen and the pH of drinking waters are such that they will not adversely affect the test fish. However, care must be taken to remove any toxic material, such as chlorine, and some temperature adjustments may be necessary. Concentrations as low as 0.5 mg/l of free available chlorine may be toxic to some species of fish. Of the species tested, bluegills and green sunfish were the most resistant. Chlorine is somewhat more toxic in soft water and in low pH water than in hard water and high pH.

Dechlorination of test waters can be accomplished either by aeration and exposure to sunlight, by passage through activated carbon, or by adding a reducing agent. When sodium thiosulfate, the selected reducing agent, was added continuously, it served as the best method and agent for a continuous monitoring system. It takes about 7 mg of sodium thiosulfate ($Na_2S_2O_3$) to reduce 1 mg of chlorine and, because it is highly soluble, it can be added continuously into the influent of a test aquarium. Sodium thiosulfate is nontoxic to fish in the required concentrations.

The optimum temperature range for warm water fish is from 20° to 28° C. They can tolerate gradual changes between 4° and 34° C, but abrupt changes of over 5° C should be avoided. Ordinary aquarium heaters will help to moderate extremes and make test reactions more valid.

Dissolved oxygen levels should remain above 4 mg/l during the tests. Lower levels may cause fish mortality or abnormal sensitivity to some toxicants.

Most species of fish can tolerate pH levels between 5 and 9, but pH changes can greatly influence the toxicity of chemicals. No recommendation is made for pH control; however, an accurate record of the pH is desirable for a subsequent interpretation of results.

False alarms that are caused by heavy metals, insecticides, or other toxicants seem less likely than the trouble that arises from chlorine. Copper, lead, and zinc can be toxic to fish in soft water above concentrations of 0.05, 0.2, and 0.5 mg/l, respectively.

F4. MONITORING APPARATUS

The simplest type of monitoring system that can be used is the direct flow of water from a tap through an aquarium that contains fish. If 5 to 10 three-inch fish are used, a volume of 10 to 20 liters with a replacement

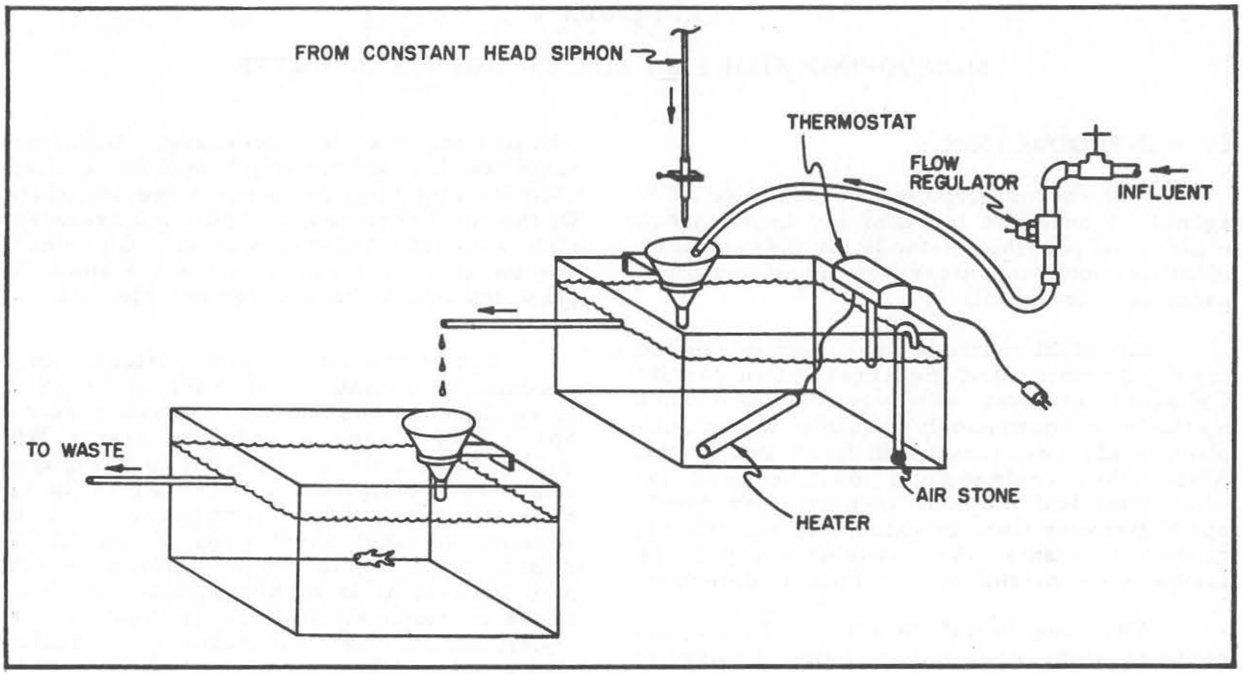

Figure F-1. Continuous-Flow Monitoring Apparatus

time of 1 to 2 hours is adequate to get a rapid response of the fish to possible contaminants.

Modifications are necessary in most cases to dechlorinate water and to control water temperature. Figure F-1 shows a suitable monitoring apparatus. Accurate records of temperature, dissolved oxygen, pH, alkalinity, and hardness are useful if any estimates of concentration of possible contaminant are to be made.

Very little maintenance is required for this continuous flow system. Dead or diseased fish should be removed and replaced with fresh stock. The fish should be fed about three times a week with a dry food, and the aquarium should be cleaned occasionally. The thiosulfate solution will have to be prepared about twice a week. A stock of a reasonable number of test fish should be kept on hand.

F5. TOXICITY OF CW AGENTS

Nerve gases are considered the chemical agents with greatest potential for use in contaminating water.

Table F-1 shows the variation in resistance of five species of test fish to Sarin in soft and hard water. Of these, bluegills were found to be the most sensitive species and goldfish the most resistant.

TABLE F-1

Comparative Toxicity of Sarin to Five Species of Fish in Soft and Hard Waters

Test fish	Dilution water	TL_m for Sarin[1] (μg/liter)		
		24 hr	48 hr	96 hr
Bluegills	Soft	7.5	3.2	3.2
	Hard	23.5	23.5	23.5
Green sunfish	Soft	4.6	4.2	4.2
	Hard	15.2	15.2	15.2
Fathead minnows	Soft	6.5	5.3	4.4
	Hard	32.1	31.9	31.9
Guppies	Soft	8.3	7.2	7.2
	Hard	21.0	14.5	13.8
Goldfish	Soft	16.1	11.8	9.8
	Hard	--	--	--

[1] TL_m median tolerance limit, μg/liter, concentration that causes 50-percent mortality of test fish.

F6. TIME OF EFFECT, CONCENTRATION RELATIONSHIPS

The time of response (loss of equilibrium or death) of fish is dependent upon the

concentration of a toxicant, with the response time usually more rapid with the increasing concentration of the chemical. By exposing fish to known concentrations of a toxicant, a time of effect-concentration relationship can be established (see Figure F-2). Unknown concentrations can thus be estimated from the time of fish reaction. Because the human tolerance of Sarin is 0.5 mg/l, fish were exposed to this concentration and the reaction time was noted. When the 50-percent loss of equilibrium was used as an end point, this

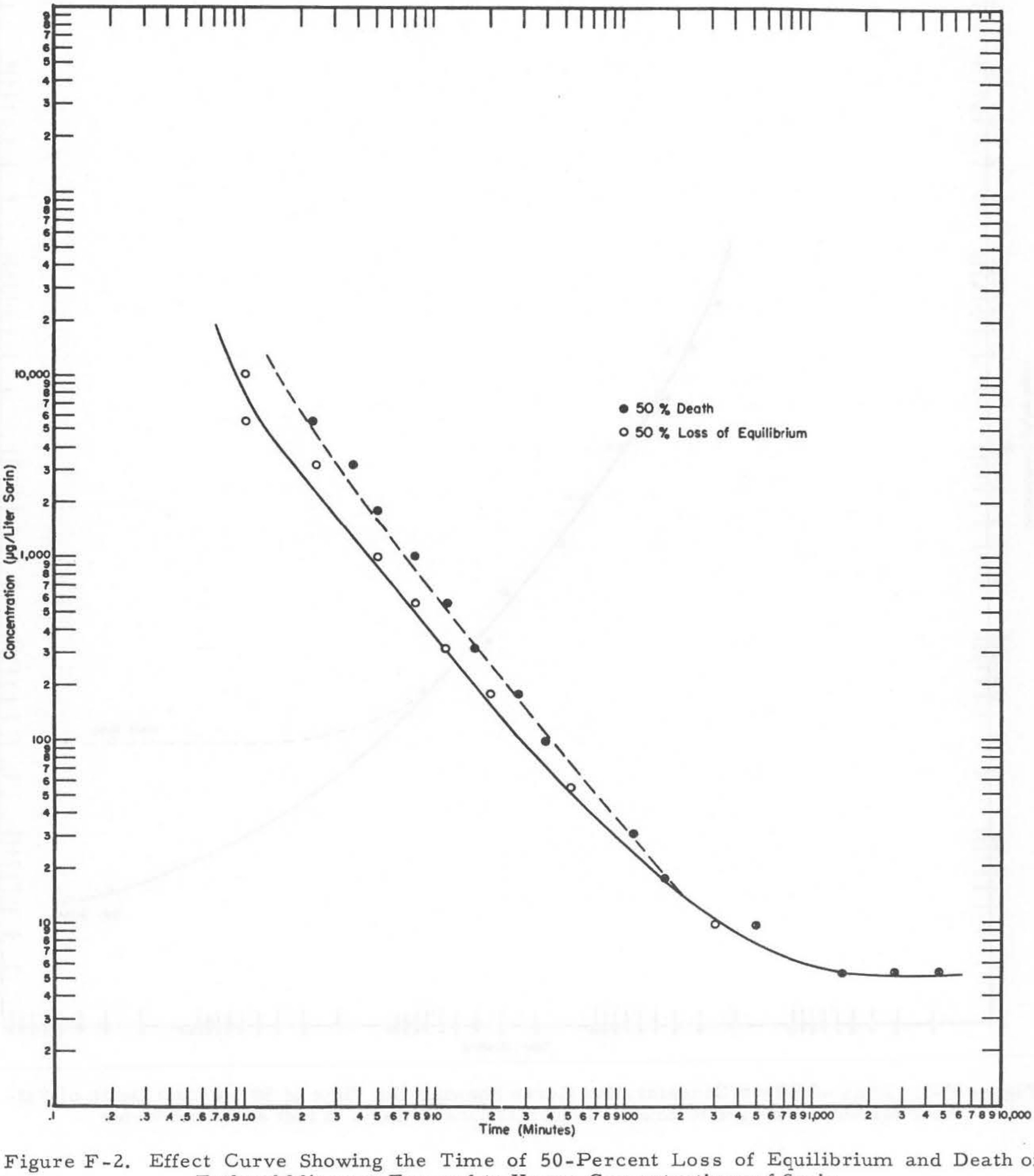

Figure F-2. Effect Curve Showing the Time of 50-Percent Loss of Equilibrium and Death of Fathead Minnows Exposed to Known Concentrations of Sarin

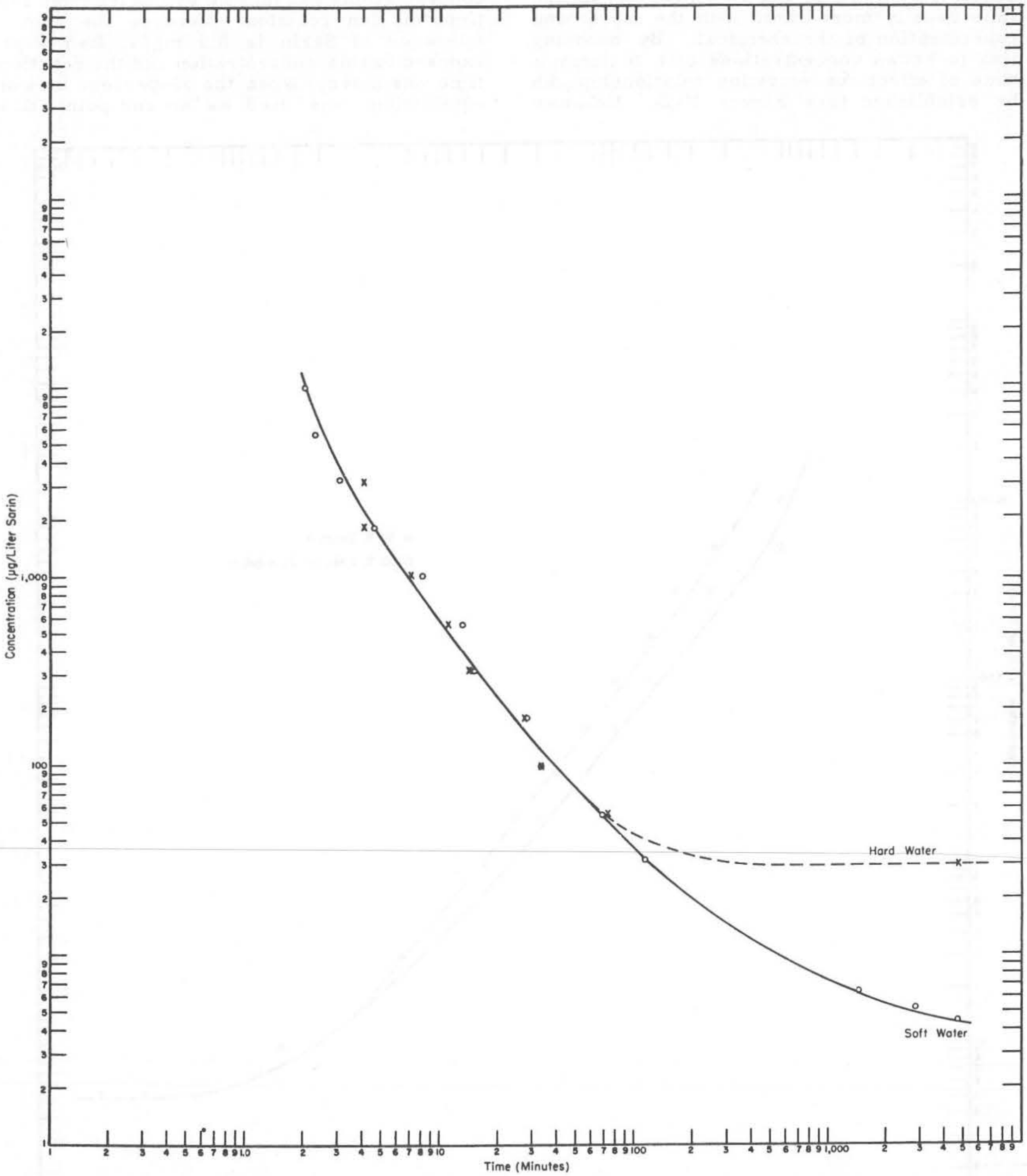

Figure F-3. Time of Effect-Concentration Curve Showing the Time of 50-Percent Death of Fathead Minnows Exposed to Known Concentrations of Sarin in Soft and Hard Water

concentration could be detected in eight minutes; when the 50-percent death criteria was used, the detection time was twelve minutes.

The time of effect-concentration curve presented in Figure F-3 shows the effect of water quality on the time of 50-percent death of fish.

The general response of fish to Sarin is somewhat similar in all concentrations, but of course each sequence of events is of shorter duration in the higher concentrations. With fathead minnows, the initial response was an increase in the depth and rate of respiration followed by an increase in activity. This was followed by a period of high excitability with body tremors, and then a complete loss of equilibrium, after which they soon died. The most conspicuous feature was the exaggerated respiratory action, extension of gill covers, and a wide opening of the mouth. The extension of the pectoral fins forward was a response that was observed with organic phosphorus compounds that had not been observed with other chemicals.

APPENDIX G

ABBREVIATIONS, GLOSSARY, AND BIBLIOGRAPHY

ABBREVIATIONS

Form	Term	Form	Term
AC	hydrogen cyanide	HD	distilled mustard
AW	atomic warfare	HN-1	nitrogen mustard
BW	biological warfare	HT	mustard--T mixture
cc	cubic centimeter	kt	kiloton
cal	calorie	L	Lewisite
cal/sq cm	calories per square centimeter	LCt	unit of lethal dose of war gas (c, concentration; t, time)
CG	phosgene	LD	lethal dose
CK	cyanogen chloride	Mev	million electron volts (see Glossary)
cm	centimeter	$\mu g/m^2$	microgram per square meter
Ct	measure of dose from CW agent. (Concentration in mg/m^3 multiplied by time, t, or length of exposure.)	mg	milligram
		mg/m^3	milligrams per cubic meter
cu yd	cubic yard	mt	megaton
CW	chemical warfare	ppm	parts per million
CX	phosgene oxime	psi	pounds per square inch
dpm	disintegrations per minute	r	roentgen
dps	disintegrations per second	r/hr	roentgens per hour
dps/cc	disintegrations per second per cubic centimeter	Rad	unit of absorbed dose of radiation (see Glossary)
ED	ethyl dichloroarsine	Rbe	relative biological effectiveness
GA	tabun	Rem	unit of neutron radiation dose (see Glossary)
GB	sarin	Rep	unit of absorbed dose of radiation (see Glossary) (roentgen equivalent physical)
GD	soman		
GZ	ground zero	RW	radiological warfare
H	mustard	sq cm	square centimeter(s)

GLOSSARY

ABC WARFARE DEFENSE: Those disaster control measures employed to minimize the effects of atomic, biological, and chemical attacks.

ACTIVE IMMUNITY: Immunity resulting from the production of antibodies by the individual's own body cells in response to a stimulus provided by the presence of antigen in the tissues.

ACUTE: Having a short and relatively severe course.

AEROSOL: A suspension of fine solid or liquid particles in air or gas, such as smoke, fog, or mist.

AIRBURST: The explosion of a nuclear weapon at such a height that the expanding ball of fire does not touch the earth's surface when the luminosity is a maximum (in the second pulse). A typical airburst is one for which the height of burst is such as may be expected to cause maximum blast destruction in an average city.

ALPHA PARTICLE: A particle emitted spontaneously from the nuclei of some radioactive elements. It is identical with a helium nucleus, having a mass of four units and an electric charge of two positive units.

ANTHRAX: An infectious and usually fatal disease of animals, especially cattle and sheep.

ANTIBIOTICS: Substances produced by and obtained from living cells, usually those of lower plants, such as bacteria and molds; they are antagonistic to other forms of life, including pathogenic organisms. Examples are penicillin and streptomycin. Some may also be produced synthetically.

ANTIBODY: A specific substance produced by the body in reaction to a specific foreign body (antigen), such as bacteria and toxins; examples are antitoxins and agglutinins.

ANTIGEN: Any substance which when introduced in the body stimulates the formation of an antibody. Antigens are usually protein in nature and react in an antagonistic manner with specific antibodies.

ANTITOXIN: A substance found in the blood serum or other body fluids which is specifically antagonistic to a toxin.

APHTHOUS FEVER: Foot-and-mouth disease; characterized by whitish spots in the mouth.

ARACHNID: One of a class of arthropods, including the ticks, mites, spiders, and scorpions.

ARTHROPOD: One of a class of animals with segmented body and jointed legs; examples are insects, arachnids, and crustaceans.

ATOM: The smallest (or ultimate) particle of an element that still retains the characteristics of that element. Every atom consists of a positively charged central nucleus, which carries nearly all the mass of the atom, surrounded by a number of negatively charged electrons, so that the whole system is electrically neutral. See Element, Electron, Nucleus.

ATOMIC BOMB (OR WEAPON): An instrument of combat which utilizes nuclear energy as a principal means for inflicting blast, thermal, and nuclear radiation damage upon an enemy.

ATOMIC CLOUD: An all-inclusive term for the mixture of hot gases, smoke, dust, and other particulate matter from the bomb itself and from the environment, which is carried aloft in conjunction with the rising ball of fire produced by the detonation of a nuclear (or atomic) weapon.

ATOMIC DEFENSE: Defensive measures against the effects of atomic attack, including defense against blast and fires; is a more general term than radiological defense, which is concerned only with radiological hazards.

AW: Abbreviation for atomic warfare.

BACKGROUND RADIATION: Nuclear (or ionizing) radiations arising from within the body and from the surroundings to which individuals are always exposed. The main sources of the natural background radiation are potassium-40 in the body, potassium-40 and thorium, uranium, and their decay products (including radium) present in rocks, and cosmic rays.

BACTERIA: One-celled micro-organisms that have no chlorophyl and multiply by dividing in 1, 2, or 3 directions of space.

BASE SURGE: A cloud which rolls outward from the bottom of the column produced by a subsurface burst of an atomic weapon. For underwater bursts the surge is, in effect, a cloud of liquid droplets which has the property of flowing almost as if it were a homogeneous fluid. For subsurface land bursts the surge is made up of small solid particles but still behaves like a fluid.

BETA PARTICLE: A charged particle of very small mass emitted spontaneously from the nuclei of certain radioactive elements. Most (if not all) of the fission fragments emit (negative) beta particles. Physically, the beta particle is identical with an electron moving at high velocity.

BIOLOGICAL AGENTS: Viruses, any of certain classifications of micro-organisms and toxic substances derived from living organisms used to produce death or disease in man, animals, and growing plants.

BIOLOGICAL WARFARE: Employment of living organisms, toxic biological products, and chemical plant growth regulators to produce death or casualities in man, animals, or plants; or defense against such action.

BLAST LOADING: The loading (or force) on an object caused by the air blast from an explosion striking and flowing around the object. It is a combination of overpressure (or diffraction) and dynamic pressure (or drag) loading.

BLAST WAVE: A pressure pulse of air, accompanied by winds, propagated continuously from an explosion.

BOTULISM: Any poisoning by the Toxin from the bacterium, Clostridium botulinum; infects preserved food, especially sausages, canned meat, fruit, or fodder.

BUFFER ZONE: Additional strips around a reclaimed working area to obtain the desired reduction in radiation field at the edge of the working area.

BW: Abbreviation for biological warfare.

CARRIER: An individual who harbors specific disease organisms without showing symptoms, thus serving as a means of conveying infection.

CASUALTY GAS: War gas capable of producing serious injury or death in effective concentrations.

CELL: A small mass of protoplasm, generally including a nucleus, surrounded by a semipermeable membrane or cell wall. It is the structural and functional unit of all living organisms, plant and animal, with the possible exception of viruses.

CHEMICAL SPRAY: Aerial release or device for aerial release of liquid war gas for casualty effect, or of liquid smoke for aerial smoke screens. See airplane smoke tank.

CHEMICAL WARFARE: Tactics and technique of conducting warfare by use of chemical agents.

CHLORINATION: The use of chlorine to destroy harmful micro-organisms as in the purification of water.

CHOKING GAS: Casualty gas which causes irritation and inflammation of the bronchial tubes and lungs. Phosgene is an example of this type of gas.

CHRONIC: Long continued; opposite of acute.

CLOUD COLUMN: The visible column of smoke extending upward from the point of burst of a nuclear (or atomic) weapon. The cloud column from an air burst may extend to the tropopause, i.e., the boundary between the troposphere and the stratosphere.

COLLECTIVE PROTECTION: Equipment, installation, and techniques used by a unit or small group for defense of personnel, materiel, and animals against any type of attack, including chemical, biological, and radiological attack.

COLONY: A collection or group of micro-organisms in a culture; they are derived from the increase of a single organism or group of organisms. On solid culture media a colony may be visible to the naked eye.

COMMAND CENTER: A term that signifies the location of the command headquarters or center from which operations and communications within its responsible area are controlled.

COMMUNICABLE: Capable of being transmitted from one individual to another.

CONCENTRATION: Amount of war gas or screening smoke present in a given volume of air; expressed in milligrams per cubic meter (mg/m^3).

CONTAGIOUS: Transmissible from one individual to another.

CONTAGIOUS DISEASE: An infectious disease capable of being transmitted from one individual to another. Many infectious diseases are not contagious but require some special method of transmission or inoculation.

CONTAMINATION: The deposit of radioactive material, biological warfare agents, or chemical warfare agents on the surface of structures, areas, personnel or objects. In the case of radioactive material, the material may be produced by an atomic explosion, or may be distributed by deliberate spread of radiological material produced by other means.

COUNTERMEASURES: Actions taken to reduce the effectiveness of enemy weapons; measures taken to permit use of an area at an earlier time after a contaminating attack than would be otherwise possible; term includes all pre-attack and post-attack measures whose effectiveness can be expressed in terms of a residual number.

COVERT: Hidden, concealed, insidious.

CUBE ROOT LAW: A scaling law applicable to many blast phenomena. It relates the time and distance at which a given blast effect is observed to the cube root of the energy yield of the explosion.

CURIE: A unit of radioactivity; it is the quantity of any radioactive species in which 3.700×10^{10} nuclear disintegrations occur per second. The gamma curie is sometimes defined correspondingly as the quantity of material in which this number of disintegrations per second are accompanied by the emission of gamma rays.

CUTANEOUS: Pertaining to the skin.

CW: Abbreviation for chemical warfare.

DAMAGE CRITERIA: Standards or measures used in estimating specific levels of damage.

DECAY (OR RADIOACTIVE DECAY): The decrease in activity of any radioactive material with the passage of time, due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, sometimes accompanied by gamma radiation.

DECONTAMINANT: Anything that is used to bring about decontamination of a person, object, or area.

DECONTAMINATION: The process of making any object or area safe for unprotected personnel by absorbing, destroying, neutralizing, making harmless, or removing chemical, biological, or radiological agents clinging to or around it.

DETECTOR: Chemical, electrical, or mechanical device for detection and identification of chemical agents, biological agents, or radioactive materials.

DIFFRACTION: The bending of waves around the edges of objects. In connection with a blast wave impinging on a structure, diffraction refers to the passage around and envelopment of the structure by the blast wave. Diffraction loading is the force (or loading) on the structure during the envelopment process.

DISASTER: A situation, usually catastrophic in nature, in which numbers of persons are plunged into helplessness and suffering and, as a result, may be in need of food, clothing, shelter, medical care, and other basic necessities of life.

DISASTER CONTROL: Consists of measures taken to reduce the probability and to minimize the effects of damage caused by hostile action, without employing active weapons or initiating offensive action; the defense of base without the use of active weapons and without taking the initiative.

DISASTER CONTROL CENTER: A fixed facility at activities and commands from which passive defense measures are controlled or coordinated; may be a separate facility or it may be a part of a command center or control center.

DISINFECT: To free from pathogenic organisms or to destroy them.

DISINFECTANT: An agent, usually chemical, that destroys infective agents.

DISPERSAL: Act of separating personnel, material, or activities which are concentrated in target areas in order to reduce vulnerability to enemy action.

DISPERSAL IN TIME: Use of work shifts to ensure that only a fraction of the work force is in the area at one time.

DOSE: A (total or accumulated) quantity of ionizing (or nuclear) radiation. The term dose is often used in the sense of the exposure dose, expressed in roentgens, which is a measure of the total amount of ionization that the quantity of radiation could produce in air. This should be distinguished from the absorbed dose, given in reps or rads, which represents the energy absorbed from the radiation per gram of specified body tissue. Further, the biological dose, in rems, is a measure of the biological effectiveness of the radiation exposure. See Rad, Rbe, Rem, Rep, Roentgen.

DOSE RATE: As a general rule, the amount of ionizing (or nuclear) radiation to which an individual would be exposed per unit of time. It is usually expressed as roentgens per hour or in multiples or submultiples of these units, such as milliroentgens per hour. The dose rate is commonly used to indicate the level of radioactivity in a contaminated area.

DOSIMETER: An instrument used to measure the total amount of radiation absorbed during a period of time.

DOSIMETRY: The theory and application of the principles and techniques involved in the measurement and recording of radiation doses. Its practical aspect is concerned with the use of various types of radiation instruments with which measurements are made.

DRAG LOADING: The force on an object or structure due to the transient winds accompanying the passage of a blast wave. The drag pressure is the product of the dynamic pressure and a coefficient which is dependent upon the shape (or geometry) of the structure or object.

DYNAMIC PRESSURE: The air pressure that results from the mass air flow (or wind) behind the shock front of a blast wave. It is equal to the product of half the density of the air through which the blast wave passes and the square of the particle (or wind) velocity in the wave as it impinges on the object or structure.

ELECTRON: A particle of very small mass, carrying a unit negative or positive charge. Negative electrons, surrounding the nucleus, are present in all atoms; their number is equal to the number of positive charges (or protons) in the particular nucleus. The term electron, where used alone, commonly refers to these negative electrons. A positive electron is usually called a positron, and a negative electron is sometimes called a negatron.

ELEMENT: One of the basic substances (or a kind of matter) which cannot be decomposed by chemical means into simpler substances. It is also a subdivision of a Diaster Control Unit; elements are composed of diaster control teams.

EMERGENCY SCENE: The general location of an incident of disaster proportions, whether resulting from natural causes or enemy attack.

EMERGENCY RECOVERY STATIONS: Locations established in one or more sections of an emergency scene; point of contact for all diaster control teams of one element conducting operations within that section. These stations are designated by a short title, the first word of which indicates the Element of which it is a part, and the second work indicates the section to which it belongs; e.g., Engineer One is the contact point for all Engineer Element teams operating in Section I of the emergency scene.

ENDEMIC: Native to, or prevalent in, a particular district or region; an endemic disease has a low incidence but is constantly present in a given community.

ENTRY TIME: The predicted time at which radioactivity in a particular location will have decayed, or contamination diffused to an intensity permitting entry of personnel under wartime conditions.

EPIDEMIC: An outbreak of disease which spreads rapidly and attacks many individuals in the same region at the same time. Analogous to epiphytotic in plants and epizootic in animals.

EXOTOXIN: A poisonous substance excreted by a living organism.

FALLOUT: The process or phenomenon of the fall back to the earth's surface of particles contaminated with radioactive material from the atomic cloud. The term is also applied in a collective sense to the contaminated particulate matter itself.

FILM BADGE: A photographic film packet to be carried by personnel, in the form of a badge, for measuring and permanently recording (usually) gamma ray dosage.

FIREBALL: The luminous sphere of hot gases which forms a few millionths of a second after detonation of atomic weapon and immediately starts expanding and cooling.

FIRE PROTECTION: All measures relating to the prevention, detection, and control of fire.

FIRE STORM: Stationary mass fire, generally in built-up urban areas, generating strong, inrushing winds from all sides, which keep the fires from spreading while adding fresh oxygen to increase their intensity.

FISSION: A form of asexual reproduction in which the cell divides into two or more parts, each of which matures into a complete organism. Atomic fission is the splitting of an atomic nucleus, as the result of bombardment by neutrons, into two or more atomic nuclei.

FISSION PRODUCTS: A general term for the complex mixture of substances produced as a result of nuclear fission. A distinction should be made between these and the direct fission products or fission fragments which are formed by the actual splitting of the heavy-element nuclei. Something like 80 different fission fragments result from roughly 40 different modes of fission of a given nuclear species, e.g., uranium - 235 or plutonium - 239. The fission fragments, being radioactive, immediately begin to decay, forming additional (daughter) products, with the result that the complex mixture of fission products so formed contains about 200 different isotopes of over 30 elements.

FIXED SUPPORT: The rendering of assistance to a critical target area or stricken activity at facilities outside its mutual aid area, including extension of facilities for emergency dispersal and evacuation before and after attack, emergency feeding, housing, hospitalization, and traffic control.

FLAME DECONTAMINATION: A reclamation method that loosens the contamination from the surface by means of heat, so that brushes or abrasive tools can readily remove the contamination.

FLASH BURN: A burn caused by excessive exposure (of bare skin) to thermal radiation.

FREE AIR OVERPRESSURE (OR FREE AIR PRESSURE): The unreflected pressure, in excess of the ambient atmospheric pressure, created in the air by the blast wave from an explosion.

FUMIGATION: Exposure to fumes of a chemical which destroys micro-organisms.

FUNGUS: Any one of a group of thallophytic plants comprising the molds, mildews, rusts, smuts, and mushrooms; they do not contain chlorophyl and reproduce mainly by asexual spores.

FUSION: The process whereby the nuclei of light elements, especially those of the isotopes of hydrogen, namely, deuterium and tritinum, combine to form the nucleus of a heavier element with the release of substantial amounts of energy.

GAMMA RAYS (OR RADIATIONS): Electromagnetic radiations of high energy originating in atomic nuclei and accompanying many nuclear reactions, e.g., fission, radioactivity, and neutron capture. Physically, gamma rays are identical with X-rays of high energy, the only essential difference being that the X-rays do not originate from atomic nuclei, but are produced in other ways, e.g., by slowing down (fast) electrons of high energy.

GERM: Micro-organism; microbe.

GROUND ZERO: The point on the surface of land or water vertically below or above the center of a burst of an atomic weapon; frequently abbreviated to GZ. For a burst over or under water, the term surface zero should preferably be used.

HALF-LIFE: The time required for the activity of a given radioactive species to decrease to half of its initial value due to radioactive decay. The half-life is a characteristic property of each radioactive species and is independent of its amount or condition. The biological half-life is the time required for the amount of a specified element which has entered the body (or a particular organ) to be decreased to half of its initial value as a result of natural, biological elimination processes. The effective half-life of a given isotope is the time in which the quantity in the body will decrease to half as a result of both radioactive decay and biological elimination.

HALF-VALUE LAYER THICKNESS: The thickness of a given material which will absorb half the gamma radiation incident upon it. This thickness depends on the nature of the material--it is roughly inversely proportional to its density--and also on the energy of the gamma rays.

HARASSING AGENT: Any chemical agent used primarily to force masking of personnel.

H-BOMB: An abbreviation for hydrogen bomb.

HEIGHT OF BURST: The height above the earth's surface at which a bomb is detonated in the air. The optimum height of burst for a particular target (or area) is that at which it is estimated a weapon of a specified energy yield will produce a certain desired effect over the maximum possible area.

HOST: An animal or plant which harbors or nourishes another organism.

HOT SPOT: Region in a contaminated area in which the level of radioactive contamination is somewhat greater than in neighboring regions in the area.

HYDROGEN BOMB (OR WEAPON): A term sometimes applied to nuclear weapons in which part of the explosive energy is obtained from nuclear fusion (or thermonuclear) reactions.

HYDROLYSIS: The reaction of any chemical with water whereby one or more new substances are created.

IMMUNITY: The power of the body to resist the development of a disease or to counteract a toxin.

INCENDIARY: A material that generates sufficient heat upon ignition under field conditions to cause the ignition of adjacent combustible substances.

INCUBATION PERIOD: Time between which infection occurs and first symptoms appear.

INDUCED RADIOACTIVITY: Radioactivity produced in certain materials as a result of nuclear reactions, particularly the capture of neutrons, which are accompanied by the formation of unstable (radioactive) nuclei. The activity induced by neutrons from a nuclear (or atomic) explosion in materials containing the elements sodium, manganese, silicon, or aluminum may be significant.

INFECTIOUS DISEASE: One which is caused by a living agent such as bacteria, protozoa, viruses, or fungi; may or may not be contagious.

INGESTION: The act of taking in, or swallowing for digestion, as into the stomach.

INITIAL NUCLEAR RADIATION: Nuclear radiation (essentially neutrons and gamma rays) emitted from the ball of fire and the cloud column during the first minute after a nuclear (or atomic) explosion. The time limit of one minute is set, somewhat arbitrarily, as that required for the source of the radiations (fission products in the atomic cloud) to attain such a height that only insignificant amounts reach the earth's surface.

INOCULATE: To introduce a micro-organism, disease, vaccine, or immunizing serum into the body; to communicate a mild form of disease by inserting its virus into the skin in order to produce immunity.

INTENSITY: The energy (of any radiation) incident upon (or flowing through) unit area, perpendicular to the radiation beam, in unit time. The intensity of thermal radiation is generally expressed in calories per square centimeter per second falling on a given surface at any specified instant. As applied to nuclear radiation, the term intensity is sometimes used, rather loosely, to express the exposure dose rate at a given location, e.g., in roentgens (or milliroentgens) per hour.

INTERNAL RADIATION: Nuclear radiation (alpha and beta particles and gamma radiation) resulting from radioactive substances in the body. Important sources are iodine-131 in the thyroid gland, and strontium-90 and plutonium-239 in the bone.

IONIZING RADIATION: Electromagnetic radiation (gamma rays or X-rays) or particulate radiation (alpha particles, beta particles, neutrons, etc.) capable of producing ions, i.e., electrically charged particles, directly or indirectly in its passage through matter.

IRRITANT AGENT: Chemical agent; toxic in field concentrations; usually not lethal.

IRRITANT SMOKE: An irritant smoke (sternutator) is a chemical agent that can be disseminated as extremely small solid or liquid particles in air and which when so disseminated and breathed even in low concentrations, causes intolerable sneezing, coughing, lacrimation, or headache, followed by nausea, temporary physical disability, and sometimes mental depression.

ISOTOPES: Forms of the same element having identical chemical properties but differing in their atomic masses (due to different numbers of neutrons in their respective nuclei) and in their nuclear properties, e.g., radioactivity, fission, etc. For example, hydrogen has three isotopes, with masses of 1 (hydrogen), 2 (deuterium), and 3 (tritium) units, respectively. The first two of these are stable (nonradioactive), but the third (tritium) is a radioactive isotope. Both of the common isotopes of uranium, with masses of 235 and 238 units, respectively, are radioactive, emitting alpha particles, but their half-lives are different. Further, uranium-235 is fissionable by neutrons of all energies, but uranium-238 will undergo fission only with neutrons of high energy.

JAUNDICE: A diseased condition, characterized by yellowing of the skin and eyes and by a deep yellow color of the urine; this yellowing is due to the presence of bile pigments in the blood and tissue. Jaundice is also known as icterus.

KILOTON ENERGY: The energy of a nuclear (or atomic) explosion which is equivalent to that produced by the explosion of 1 kiloton (i.e., 1,000 tons) of TNT, i.e., 10^{12} calories or 4.2×10^{19} ergs.

LACRIMATOR: A chemical agent that causes a copious flow of tears and temporary but intense eye pain.

LD-50, LD/50, or LD_{50}: Abbreviations for median lethal dose.

LETHAL CONCENTRATION: The concentration of an agent that will kill the average unprotected man.

LOADING: The force on an object or structure or element of a structure. The loading due to blast is equal to the net pressure in excess of the ambient value multiplied by the area of the loaded object.

LUNG IRRITANT: A chemical agent which, when breathed, causes irritation and inflammation of the interior portion of the bronchial tubes and lungs; the primary physiological action of such an agent is limited to the respiratory tract.

MACH REGION: The region on the surface at which the Mach stem has formed as the result of a particular explosion in the air.

MACH STEM: The shock front formed by the fusion of the incident and reflected shock fronts from an explosion. The term is generally used with reference to a blast wave, propagated in the air, reflected at the surface of the earth. The mach stem is nearly perpendicular to the reflecting surface and presents a slightly convex (forward) front. The Mach stem is also called the Mach front.

MAXIMUM PERMISSIBLE EXPOSURE (or Mpe): The total amount of radiation exposure which it is believed a normal person may receive day-by-day without any harmful effects becoming evident during his lifetime.

MEDIAN LETHAL DOSE: The amount of radiation received over the whole body which would be fatal to about 50 percent of human beings, or animals, or organisms. It is commonly (although not universally) accepted, at the present time, that a dose of about 450 roentgens, received over the whole body in the course of a few hours or less, is the median lethal dose for human beings.

MEDIAN LETHAL GAS EXPOSURE (LCt_{50}): The exposure of a war gas required to kill 50 percent of those exposed. The unit used to express LCt_{50} is milligram minutes per cubic meter.

MEGATON ENERGY: The energy of a nuclear (or atomic) explosion which is equivalent to 1,000,000 tons (or 1,000 kilotons) of TNT, i.e., 10^{15} calories or 4.2×10^{22} ergs.

MEV (OR MILLION ELECTRON VOLTS): A unit of energy commonly used in nuclear physics. It is equivalent to 1.6×10^{-6} erg. Approximately 200 mev of energy are produced for every nucleus that undergoes fission.

MICROBE: Any individual micro-organism.

MICRO-ORGANISM: Minute living organism, usually microscopic in size.

MILLIROENTGEN: A one-thousandth part of a roentgen.

MOBILE SUPPORT: The assistance rendered to a target area or critical target area by emergency recovery organizations dispatched from outside the mutual aid area.

MONITORING: The procedure or operation of locating (and measuring) radioactive contamination by means of survey instruments which can detect and measure (as dose rates) ionizing radiations. The individual performing the operation is called a monitor.

MUTUAL AID: The organization of local forces within a target area or a critical target area, built around the resources of the political subdivisions, military activities, and Federal agencies within the area; these resources can be coordinated for the common defense of the target area.

NERVE GAS: War gas that, when absorbed into the body by breathing, by ingestion, or through the skin, affects the various body functions by its primary action on the nerve structures of the body.

NEUTRON: A neutral particle, i.e., with no electrical charge, of approximately unit mass, present in all atomic nuclei, except those of ordinary (or light) hydrogen. Neutrons are required to initiate the fission process, and large numbers of neutrons are produced by both fission and fusion reactions in nuclear (or atomic) explosions.

NOMINAL ATOMIC BOMB: A term, now becoming obsolete, formerly used to describe an atomic weapon with an energy release equivalent to 20 kilotons (i.e., 20,000 tons) of TNT. This was approximately the energy yield of the bombs exploded over Japan and in the Bikini tests in 1946.

NUCLEAR RADIATION: Particulate and electromagnetic radiation emitted from atomic nuclei in various nuclear processes. The important nuclear radiations, from the weapons standpoint, are alpha and beta particles, gamma rays, and neutrons. All nuclear radiations are ionizing radiations, but the reverse is not true; X-rays, for example, are included among ionizing radiations, but they are not nuclear radiations since they do not originate from atomic nuclei.

NUCLEAR WEAPON (OR BOMB): A general name given to any weapon in which the explosion results from the energy released by reactions involving atomic nuclei, either fission or fusion or both. Thus, the A (or atomic) bomb and the H (or hydrogen) bomb are both nuclear weapons. It would be equally true to call them atomic weapons, since it is the energy of atomic nuclei that is involved in each case. However, it has become more or less customary, although it is not strictly accurate, to refer to weapons in which all the energy results from fission as A bombs, or atomic bombs. In order to make a distinction, those weapons in which part, at least, of the energy results from thermonuclear (fusion) reactions among the isotopes of hydrogen have been called H bombs, or hydrogen bombs.

NUCLEUS (OR ATOMIC NUCLEUS): The small, central, positively charged region of an atom that carries essentially all the mass. Except for the nucleus of ordinary (light) hydrogen, which is a single proton, all atomic nuclei contain both protons and neutrons. The number of protons determines the total positive charge, or atomic number; this is the same for all the atomic nuclei of a given chemical element. The total number of neutrons and protons, called the mass number, is closely related to the mass (or weight) of the atom. The nuclei of isotopes of a given element contain the same number of protons, but different numbers of neutrons. They thus have the same atomic number, and so are the same element, but they have different mass numbers (and masses). The nuclear properties, e.g., radioactivity, fission, neutron capture, etc., of an isotope of a given element are determined by both the number of neutrons and the number of protons.

ORGANISM: Any organized living being, animal, or plant.

OVERPRESSURE: The transient pressure, usually expressed in pounds per square inch, exceeding the ambient pressure, manifested in the shock (or blast) wave from an explosion. The variation of the overpressure with time depends on the energy yield of the explosion, the distance from the point of burst, and the medium in which the weapon is detonated. The peak overpressure is the maximum value of the overpressure at a given location and is generally experienced at the instant the shock (or blast) wave reaches that location.

OVERT: Open; manifest.

PANDEMIC: Widely epidemic, affecting or attacking all or most of the population of a region.

PARASITE: A plant or animal living in, on, or with some other living organism (the host) at whose expense it obtains food and shelter.

PASSIVE IMMUNITY: Immunity created by inoculation with an immune serum.

PATHOGEN: A disease-producing micro-organism.

PERSISTENCY: The length of time an agent will remain effective at the point of release.

PERMEABLE: Penetrable, refers to substances that allow the passage of air or fluids.

PHYSICAL SECURITY: A condition which results from the establishment and maintenance of protective measures; ensures a state of inviolability from hostile acts or influences.

PLANNING DOSE: The maximum dose that mission personnel are allowed to receive, taking into account the period of time during which it is received.

PLASTIC RANGE: The stress range in which a material will not fail when subjected to the action of a force, but will not recover completely, so that a permanent deformation results, when the force is removed. Plastic deformation refers to dimensional changes occurring within the plastic range.

PRIME TARGETS: Those concentrations of population, and/or industry and installations of the Armed Forces or Federal agencies which are considered essential to the prosecution of a war; lists of prime targets are classified information.

PROTECTIVE CONSTRUCTION: Construction designed to reduce vulnerability from the effects of enemy attack or natural disaster; including dispersal in time or space; duplicate facilities and utilities; protective personnel shelters; collective personnel protection features against high explosives, atomic, biological and chemical warfare attacks; utilization of protective terrain features; camouflage; aboveground blast, shock and fire resistant structures; and underground facilities.

PROTON: A particle of mass (approximately) unity carrying a unit positive charge; it is identical physically with the nucleus of the ordinary (light) hydrogen atom. All atomic nuclei contain protons.

PROTOZOA: One of the lowest divisions of the animal kingdom, including one-celled organisms.

RAD: A unit of absorbed dose of radiation; it represents the absorption of 100 ergs of nuclear (or ionizing) radiation per gram of the absorbing material or tissue.

RADIAC EQUIPMENT: Equipment used to detect, measure, and indicate radioactivity. The letters in the term, "radiac," represent the expression: radioactivity, detection, indications, and computation.

RADIOACTIVITY: The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nuclei of an (unstable) isotope. As a result of this emission the radioactive isotope is converted (or decays) into the isotope of a different element which may (or may not) also be radioactive. Ultimately, as a result of one or more stages of radioactive decay, a stable (nonradioactive) end product is formed.

RADIOLOGICAL WARFARE: A type of warfare in which radioactive materials are spread either directly, or from high explosive bombs, chiefly to deny an area to the enemy, or to force evacuation of any enemy-held area; not attended by a nuclear explosion.

RBE (OR RELATIVE BIOLOGICAL EFFECTIVENESS): The ratio of the number of rads of gamma (or X) radiation of a certain energy which will produce a specified biological effect to the number of rads of another radiation required to produce the same effect is the rbe of this latter radiation.

REFLECTED PRESSURE: The total pressure which results instantaneously at the surface when a shock (or blast) wave traveling in one medium strikes another medium, e.g., at the instant when the front of a blast wave in air strikes the surface of an object or structure.

RECOVERY COMPLETION TIME: The time at which the recovery job is finished, including both the recovery period and the waiting time necessary to allow recovery personnel to enter the area.

RECOVERY CONTROL POST: A facility established enroute to or at the scene of recovery operations; necessary equipment facilities, and personnel (less staff officers) provided by standard disaster control element teams; echelon of the recovery organization served by a particular recovery control post indicated by inserting the echelon designation between the words recovery and control; e.g., Recovery Group Control Post, Recovery Unit Control Post, and Recovery Section Control Post.

RECOVERY MEASURES: Steps taken after attack or disaster to restore the functional status of an activity. These measures are divided into three phases: (1) Emergency Recovery Measures, actions taken to keep loss of life and property to a minimum; (2) Operational Recovery Measures, steps taken to restore the essential utility of an activity; and (3) Final Recovery Phase, steps taken to restore all facilities required to accomplish the complete mission assignment of an activity.

REFLECTION FACTOR: The ratio of the total (reflected) pressure to the incident pressure when a shock (or blast) wave traveling in one medium strikes another.

REM: A unit of biological dose of radiation; the name is derived from the initial letters of the term "roentgen equivalent man (or mammal)." The number of rems of radiation is equal to the number of rads absorbed multiplied by the rbe of the given radiation (for a specified effect).

REP: A unit of absorbed dose of radiation; the name is derived from the initial letters of the term "roentgen equivalent physical." Basically, the rep is intended to express the amount of energy absorbed per gram of soft tissue as a result of exposure to 1 roentgen of gamma (or X) radiation. This is estimated to be about 97 ergs, although the actual value depends on certain experimental data which are not precisely known. The rep is thus defined, in general, as the dose of any ionizing radiation which results in the absorption of 97 ergs of energy per gram of soft tissue. For soft tissue the rep and the rad are essentially the same.

RESIDUAL NUCLEAR RADIATION: Nuclear radiation, chiefly beta particles and gamma rays, which persists for some time following a nuclear (or atomic) explosion. The radiation is emitted mainly by the fission products and other bomb residues in the fallout, and to some extent by earth and water constituents and other materials, in which radioactivity has been induced by the capture of neutrons.

RESIDUAL NUMBER: The decimal fraction of the radiation intensity that remains after a countermeasure is used.

RICKETTSIAE: Gram-negative, nonmotile, intracellular, one-celled parasitic micro-organisms, probably intermediate between the bacteria and viruses.

ROENTGEN: A unit of exposure dose of gamma (or X) radiation. It is defined precisely as the quantity of gamma (or X) radiation such that the associated corpuscular emission per 0.001293 gram of air produces, in air, ions carrying one electrostatic unit quantity of electricity of either sign. From the accepted value for the energy lost by an electron in producing a positive-negative ion pair in air, it is estimated that 1 roentgen of gamma (or X) radiation would result in the absorption of 87 ergs of energy per gram of air.

RW: Abbreviation for radiological warfare.

SABOTAGE: Malicious waste or destruction, especially by covert means.

SECTION: A geographic subdivision of an emergency scene bounded by the obstruction perimeter and/or the support perimeter.

SECURITY: Measures taken by a command to protect itself from espionage, observation, sabotage, annoyance, or surprise.

SCALING LAW: A mathematical relationship which permits the effects of a nuclear (or atomic) explosion of given energy yield to be determined as a function of distance from the explosion (or from ground zero), provided the corresponding effect is known as a function of distance for a reference explosion, e.g., of 1-kiloton energy yield.

SCATTERING: The diversion of radiation, either thermal or nuclear, from its original path as a result of interactions (or collisions) with atoms, molecules, or larger particles in the atmosphere or other medium between the source of the radiations, e.g., a nuclear (or atomic) explosion, and a point at some distance away. As a result of scattering, radiations (especially gamma rays and neutrons) will be received at such a point from many directions instead of only from the direction of the source.

SCREENING SMOKE: A substance dispersed in the air to produce a dense cloud of obscuring smoke to reduce visibility.

SELF-HELP MEASURES: The help which an activity administers to itself to reduce loss of life and property, and to continue its assigned mission.

SHEAR WALL: A wall (or partition) designed to take a load in the direction of the plane of the wall, as distinct from lateral loads perpendicular to the wall. Shear walls may be designed to take lateral loads as well.

SHIELDING: Any material or obstruction which absorbs radiation and thus tends to protect personnel or materials from the effects of a nuclear (or atomic) explosion. A moderately thick layer of any opaque material will provide satisfactory shielding from thermal radiation, but a considerable thickness of material of high density may be needed for nuclear radiation shielding.

SHOCK FRONT (OR PRESSURE FRONT): The fairly sharp boundary between the pressure disturbance created by an explosion (in air, water, or earth) and the ambient atmosphere, water, or earth, respectively. It constitutes the front of the shock (or blast) wave.

SHOCK WAVE: A continuously propagated pressure pulse (or wave) in the surrounding medium which may be air, water, or earth, initiated by the expansion of the hot gases produced in an explosion. A shock wave in air is generally referred to as a blast wave, because it is similar to (and is accompanied by) strong, but transient, winds. The duration of a shock (or blast) wave is distinguished by two phases. First there is the positive (or compression) phase during which the pressure rises very sharply to a value that is higher than ambient and then decreases rapidly to the ambient pressure. The duration of the positive phase increases and the maximum (peak) pressure decreases with increasing distance from an explosion of given energy yield. In the second phase, the negative (or suction) phase, the pressure falls below ambient and then returns to the ambient value. The duration of the negative phase is approximately constant throughout the blast wave history and may be several times the duration of the positive phase. Deviations from the ambient pressure during the negative phase are never large and they decrease with increasing distance from the explosion.

SLANT RANGE: The distance from a given location, usually on the earth's surface, to the point at which the explosion occurred.

SMOKE SCREEN: Cloud of smoke used to mask either friendly or enemy installations or maneuvers; may be a smoke blanket, smoke haze, smoke curtain, or blinding smoke.

SPORE: Primitive reproductive bodies or resistant resting cells produced by some plants and micro-organisms.

STAY-TIME: The period during which personnel may remain within a particular area of contamination or radiation hazard under wartime conditions.

STERILIZATION: The process of killing all living cells, especially micro-organisms, by heat, chemicals, or other means.

SUPPORT PERIMETER: A boundary of the target area where debris is first observed in the streets or where staytime is one week.

SURFACE BURST: The explosion of a nuclear (or atomic) weapon at the surface of the land or water or at a height above the surface less than the radius of the fireball at maximum luminosity (in the second thermal pulse). An explosion in which the bomb is detonated actually on the surface is called a contact surface burst or a true surface burst.

SURVEY: Determination of the location and levels of radiation (monitoring) in a radioactivity contaminated area; perimeter survey, the monitoring of boundaries of a contaminated area; vital area survey, the detailed monitoring of the vital area; location survey, the monitoring of structures and working locations within the vital area; supplementary survey, the monitoring of surfaces on which test runs of reclamation methods are being made, or the monitoring of special objects, such as food and water supplies.

SURVEY METER: A portable instrument, such as a Geiger counter or ionization chamber, used to detect nuclear radiation and to measure the dose rate.

TEAR GAS: Chemical agent which causes a blinding flow of tears and intense, though temporary, eye irritation; used for training and riot control.

THERMAL RADIATION: Electromagnetic radiation emitted (in two pulses) from the ball of fire as a consequence of its very high temperature; it consists essentially of ultraviolet, visible, and infrared radiations. In the early stages (first pulse), when the temperature of the fire-ball is extremely high, the ultraviolet radiation predominates; in the second pulse, the temperatures are lower and most of the thermal radiation lies in the visible and infrared regions of the spectrum.

THERMONUCLEAR: An adjective referring to the process (or processes) in which very high temperatures are used to bring about the fusion of light nuclei, such as those of the hydrogen isotopes, deuterium and tritium, with the accompanying liberation of energy. A thermonuclear bomb is a weapon in which part of the explosion energy results from thermonuclear fusion reactions. The high temperatures required are obtained by means of a fission explosion.

TOXICITY: The property possessed by a material that enables it to injure the physiological mechanism of an organism by chemical means with the maximum effect being death.

TOXIN: Generally any poisonous substance of microbic, vegetable, or animal origin. True toxins are of a proteinlike nature, more or less unstable, require a period of incubation or a latent period to produce symptoms, and induce in suitable animals the formation of specific antitoxins. No incubation period is involved if toxin is introduced into body; incubation period is involved only if an organism capable of producing a toxin is introduced into the body.

UNDERGROUND BURST: The explosion of a nuclear (or atomic) weapon with its center beneath the surface of the ground.

UNDERWATER BURST: The explosion of a nuclear (or atomic) weapon with its center beneath the surface of the water.

VECTOR: Carrier, especially the animal or host that carries the pathogen from one host to another, as the malarial mosquito.

VEGETATIVE CELL: Nonsporeforming bacteria or sporeforming bacteria in their nonsporing state.

VESICANT: A chemical agent that exerts a blistering effect on the skin.

VIRULENT: Exceedingly hurtful, venomous, deadly.

VIRUS: A minute infectious agent, smaller than bacteria, capable of passing through filters that will retain bacteria and of multiplying only within a living susceptible host cell.

VOMITING GAS: Chemical agent which causes coughing, sneezing, pain in nose and throat, nasal discharge, and sometimes tears--often followed by headache; may cause vomiting; formerly called irritant smoke or sternutator. Adamsite is an example of a vomiting gas.

VACCINE: Preparation of killed or attenuated infective agent used in inoculating to produce active artificial immunity.

VACCINATION: Protective inoculation with micro-organisms, killed or attenuated; protective inoculation against smallpox by inoculation with vaccinia (cowpox) virus.

WAR GAS: Toxic chemical agent, irrespective of its physical state.

YIELD (OR ENERGY YIELD): The total effective energy released in a nuclear (or atomic) explosion. It is usually expressed in terms of the equivalent tonnage of TNT required to produce the same energy release in an explosion. The total energy yield is manifested as nuclear radiation, thermal radiation, and shock (and blast) energy, the actual distribution being dependent upon the medium in which the explosion occurs (primarily) and also upon the type of weapon and the time after detonation.

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